Electronic Services - Los Angeles
M10508X

INSTRUCTIONS

MODELS 7351 & 7361
Preset Universal EPUT®
& Timer

Beckman®
INSTRUMENTS, INC.
BERKELEY DIVISION

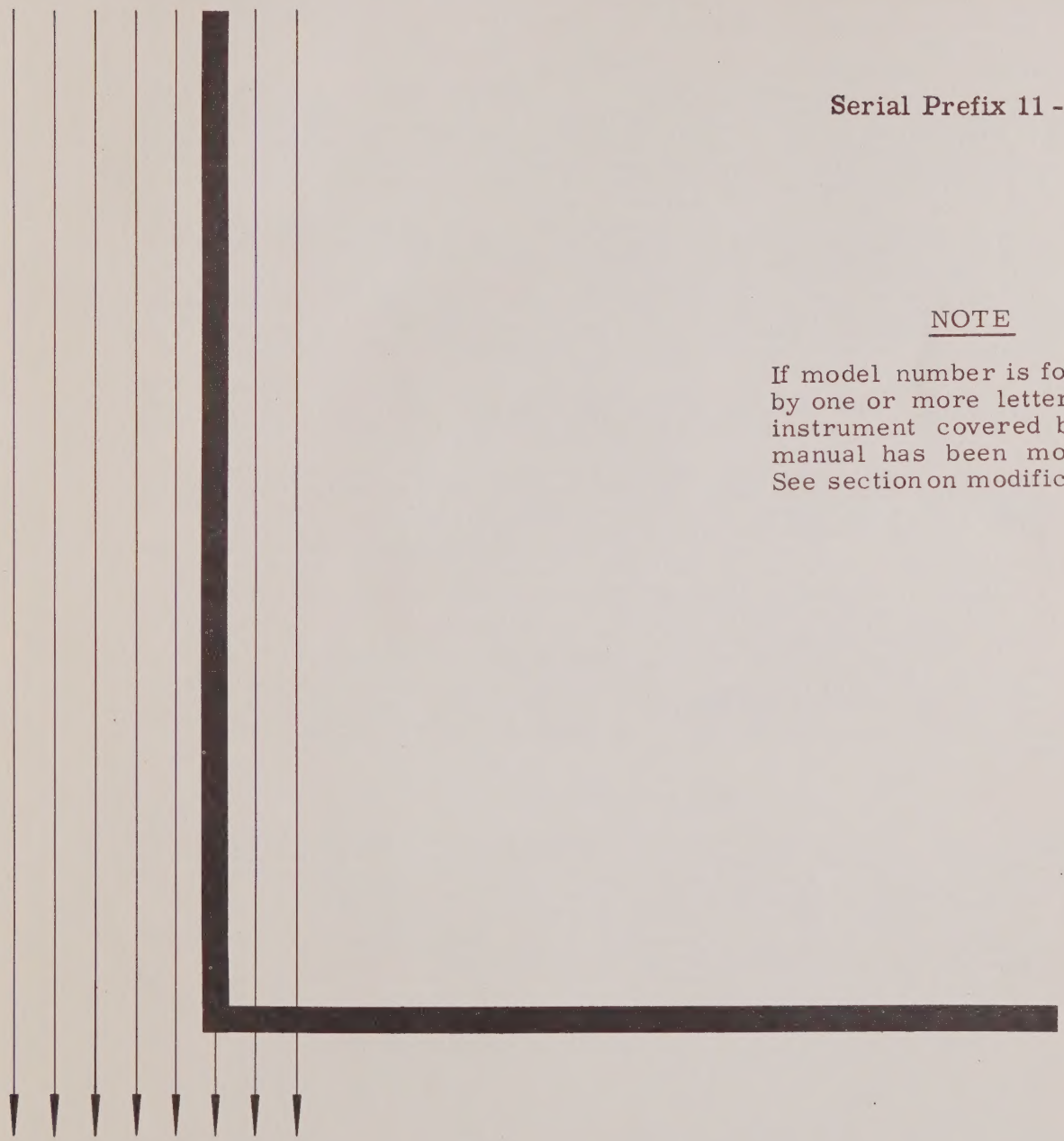
INSTRUCTION MANUAL

MODELS 7351 & 7361
Preset Universal EPUT®
& Timer

Serial Prefix 11 -

NOTE

If model number is followed by one or more letters, the instrument covered by this manual has been modified. See section on modifications.



Beckman® INSTRUMENTS, INC.
BERKELEY DIVISION
2200 Wright Avenue
Richmond, California

December 1958

WARRANTY

Instruments sold by Berkeley Division, Beckman Instruments, Inc., (hereafter called "the Company") are warranted only as stated below.

Subject to the exceptions and upon the conditions specified below, the Company agrees to correct, either by repair, or, at its election, by replacement, any defect of material or workmanship which develops within one year after delivery of the instrument to the original purchaser by the Company or by an authorized representative, provided that investigation and factory inspection by the Company discloses that such defect developed under normal and proper use.

The exceptions and conditions mentioned above are the following:

(a) Some components and accessories by their nature are not intended to, and will not, function one year. If any such component or accessory manufactured by the Company and part of the item sold fails to give reasonable service for a reasonable period of time, the Company will, at its election, replace or repair such component or accessory. What constitutes reasonable service and what constitutes a reasonable period of time shall be determined solely by the Company after the Company is in posession of all the facts concerning operating conditions and other pertinent factors and after such component or accessory has been returned to the Company, transportation prepaid.

(b) All instruments claimed defective must be returned to the Company, transportation charges prepaid, and will be returned to the customer with the transportation charges collect, unless the item is found to be defective in which case the Company will pay all transportation charges.

(c) The Company makes no warranty concerning components or accessories not manufactured by it, such as tubes, fuses, batteries, etc. However, in the event of the failure of any component or accessory not manufactured by the Company, the Company will give reasonable assistance to the purchaser in obtaining from the respective manufacturer whatever adjustment is reasonable in the light of the manufacturer's own warranty.

(d) Except as stated above, the Company makes no warranty, express or implied (either in fact or by operation of law), statutory or otherwise; and, except to the extent stated above, the Company shall have no liability under any warranty, express or implied (either in fact or by operation of law), statutory or otherwise.

(e) The Company expressly disclaims any liability to its customers, dealers, and to users of its products, and to any other person or persons for consequential damages of any kind and from any cause whatsoever arising out of or in any way connected with the manufacture, sale, repair, replacement of, or arising out of or in any way connected with the use of any of its products.

(f) Representations and warranties made by any person, including representatives of the Company, which are inconsistent or in conflict with the terms of this warranty (including but not limited to the limitation of the liability of the Company as set forth above) shall not be binding upon the Company unless reduced to writing and approved by an officer of the Company.

(g) This warranty shall be governed by the laws of the State of California.

Claims for damage in shipment should be filed promptly with the transportation company.

All correspondence concerning the instrument should specify the model and serial number. This information appears on the company name plate. Any inquiry concerning details of operation, possible modifications, etc., should be addressed to the Sales Department, Berkeley division of Beckman Instruments, Inc., Richmond 4, California.

REPAIR SERVICE

Experienced service personnel and special test equipment are available at the factory to perform any necessary repairs. Every effort will be made to expedite the repair of instruments returned for servicing. Repair work will be performed only upon receipt of a written purchase order or authorization. Instruments to be repaired should be addressed to SERVICE AND REPAIR DEPARTMENT with transportation charges prepaid. Repaired instruments will be returned to the purchaser with transportation charges collect.

Berkeley reserves the right to make changes in design at any time without incurring any obligation to modify equipment previously purchased to conform to subsequent design changes.

BERKELEY DIVISION
BECKMAN INSTRUMENTS, INC.

MANUAL REVISION

The instruments listed in Table 1 have been modified to increase their frequency range from 100 kc to 500 kc. Specifications for these instruments are:

Frequency range: DC to 500 kc

Resolution: 2 microseconds

TABLE 1

Model No.	Serial Numbers Affected
7050	322, 367, 422, 457, 459, 473, 478, 480, 482 and above
7150	1955 and above
7151	519 and above
7250	582, 583, 586 through 596, 599 and above
7350	1837 and above
7351	317, 336, 341, 343 and above
8050	108 and above
8150	131 and above
8151	135 and above
8250	104 and above
8350	120 and above
8351	113 and above

Instruments listed in Table 2 have been modified to increase their frequency range from 1 mc to 2 mc. Specifications for these instruments are:

Frequency range: DC to 2 mc

Resolution: 0.5 microsecond

TABLE 2

Model No.	Serial Numbers Affected
7060	752 and above
7160	1359 and above
7260	462 and above
7360	5276 and above
8060	110, 111, 114, 117 and above
8160	140 and above
8260	102 and above
8360	171 and above

INSTRUCTION MANUAL REVISION

Models 7351 and 7361

1. Correction

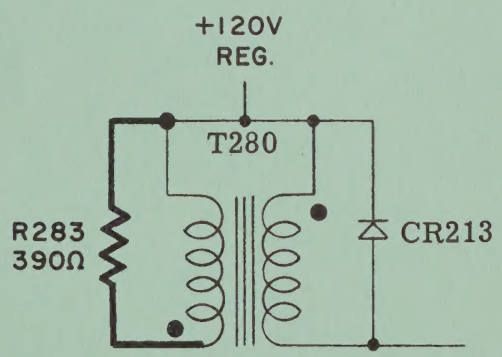
Page 36, line 6 should read:

R705 lowers the voltage at the coincidence bus to approximately ground level.

2. Addition*

Switching Schematic Diagram, Dwg. No. 3761 D 1:

Resistor R283 added in parallel with T280 (4-62)



*The addition of R283 affects all instruments with the serial #581 and above.

INSTRUCTION MANUAL REVISION

Models 7160, 7161, 7260, 7360 & 7361, also
Models 8160, 8161, 8260, 8360 & 8361, & 7360-20

Please note the following change to the 1 Mc Oscillator and Shaper schematic:

Capacitor C410 is 0.6 - 14 pf.,
Stock No. 655-824658
Mfg. JFD VC-11GRA

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TYPICAL WAVEFORMS

MODIFICATIONS (7000/8000 Series)

DRAWINGS

Diagrams covering Model 7351 Only:

Master Schematic Diagram (7351 D 1 - Rev. P)
100 KC Frequency Divider Schematic Diagram (C 405978 - Rev. B)
Time Trigger Schematic Diagram (A 414035 - Rev. A)

Diagrams covering Model 7361 Only:

Switching Schematic Diagram (7361 D 1 - Rev. D)
Gate, Control & Counting Circuit Schematic Diagram (7361 D 2 - Rev. P)
1 MC Frequency Divider Schematic Diagram (C 405979 - Rev. A)

Diagrams covering Both Models 7351 & 7361:

Input Trigger Channel Schematic Diagram (C 410723 - Rev. E)
Oscillator and Shaper Schematic Diagram (62-B-102)
Preset Digital Divider Schematic Diagram (7151 D 2 - Rev. L)
Power Supply Schematic Diagram (62-C-47)

APPENDICES

Instruction Manual, Model 785A Decimal Counting Unit
Instruction Manual, Model 775 Decimal Counting Unit
Instruction Manual, Model 774P Decimal Counting Unit
Instruction Manual, Model 774P/1 Decimal Counting Unit

1. INTRODUCTION

1.1 GENERAL DESCRIPTION

Preset Universal EPUT® and Timers are multi-purpose instruments which will perform a number of operations. The instruments consist of the following functional parts housed in a single cabinet:

(a) Two identical input trigger channels. These circuits generate one pulse for every cycle of the signal applied to the channel input.

(b) A crystal-controlled clock-pulse generator. This unit generates pulses separated by a precise time interval. Model 7351 offers three selectable intervals: 1.0 ms, 0.1 ms and .01 ms. Model 7361 offers, in addition, a one-microsecond interval.

(c) A four-decade digital divider. This will divide pulse frequencies by any number from one to 9,999, depending upon the setting of four ten-position selector switches.

(d) An electronic gate with pulse-actuated controlling circuitry. A pulse applied to the control circuitry will open the gate; a later pulse will close it. In the interval, the gate will be open to pass other pulses to counting circuitry.

(e) A chain of cascaded decimal counting units. These units count and indicate the number of pulses emerging from the gate. Model 7351 contains five indicating DCU's; Model 7361 contains six.

(f) A power supply to generate plate and filament voltages for the above circuits.

The particular function the instrument will perform depends upon how the functional parts are interconnected. All interconnections are made simply by positioning the front-panel FUNCTION switch. Each mode of operation takes its name from the FUNCTION switch engraving at that position. Modes of operation differ so greatly that it is difficult to consider the instrument's capabilities except with reference to a particular function. See sections 2.4 through 2.11.

1.2 TECHNICAL CHARACTERISTICS

Note: See sections 2.4 through 2.11 for characteristics of each mode of operation.

1.2.1 Over-All Characteristics.

Count Indication:	Appears in the form of illuminated decimal digits. Duration of display is continuously variable from 0.1 to 10 seconds.	
	Model 7351 displays five digits, will register a maximum of 99, 999 counts.	
	Model 7361 displays six digits, will register 999, 999 counts.	
Readout Facilities:	A modified binary code representing each decimal digit registered at a rear-panel connector.	
Power Requirements:	117 v. ±10%, 50 to 60 cps. Model 7351 draws 260 watts; Model 7361, 335 watts.	
Over-All Dimensions:	With cabinet:	20 in. wide, 11 in. high, 17 1/4 in. deep.
	Without cabinet:	19 in. wide, 8 3/4 in. high, 17 1/4 in. deep. (Designed to fit in standard 19 in. relay rack.)
Weight with Cabinet:	Model 7351:	Approximately 50 lbs.
	Model 7361:	Approximately 52 lbs.

1.2.2 Clock-Pulse Generator.

Output Pulse Interval:	Model 7351:	1 ms, 0.1 ms and .01 ms.
	Model 7361:	1 ms, 0.1 ms, .01 ms and 1 μs.
Frequency Error Crystal Oscillator:	Model 7351:	Set to within 1 part in 10^6 at the factory; drifts less than 1 part in 10^6 per day.
	Model 7361:	Set to within 1 part in 10^7 at the factory; drifts less than 3 parts in 10^7 per week.

1.2.3 Digital Divider.

Input:	Pulses from an input trigger channel or the clock-pulse generator. Maximum input frequency is 10 Kcs.
Output:	Every Nth input pulse, where N is any number from 1 to 9, 999.
Purpose:	Divide input pulse frequency by N. Multiplies input pulse interval by N.

1.2.4 Input Trigger Channels.

Type of Input Signal:	Channel generates a pulse for each input voltage excursion through a selected trigger voltage level. If this input is an a-c signal one effective pulse will be generated for every cycle.

Input Sensitivity:	Input excursions must be at least 0.3 volts in amplitude. This means that an a-c signal 0.3 volts peak-to-peak (100 millivolts rms) will trigger the input channel successfully. An input attenuation control is provided to attenuate the input voltage by a factor of 10 or 100 thus decreasing the sensitivity to 3 or 30 volts peak-to-peak respectively.
Input Coupling:	Choice of a-c or d-c.
Input Frequency Range:	d-c to 100 kc for the Model 7351, and d-c to 1 mc for the Model 7361. Sensitivity begins to decrease appreciably when frequencies below 5 cps are a-c coupled. Maximum input frequency is 10 kc during operations in which the channel output drives the digital divider.
Input Impedance:	10 megohms in parallel with approximately 35$\mu\mu$f. Impedance begins to drop below 10 megohms when input voltage (after attenuation) rises above +1 v d-c, falling to approximately one megohm at +10 v d-c.
Trigger Voltage Level:	Instantaneous voltage at which the attenuated signal triggers the input channel may be varied continuously from -1 v to +1 v.
Trigger Slope:	Input channel will trigger an effective pulse on either a positive-going or a negative-going input voltage excursion.

1.3 APPLICATIONS

Versatility. The Universal Preset EPUT® and Timer is a broadly useful instrument for combined counting, timing and controlling applications. It offers the functions of an EPUT® meter, a time interval meter and a counter-controller--engineered for maximum application flexibility. Preset control makes possible repeated sampling for desired intervals or control by quantity irrespective of time. The instrument is adapted to laboratory use where stability and high accuracy are essential and is equally suitable for industrial environments where ruggedness and dependability are prime requisites. A few of the known applications are listed below.

Frequency Measurements.* By counting individual cycles of input signal, accuracy as great as a few parts in 10^7 (Model 7361) or a few parts in 10^6 (Model 7351) are possible. See "E/UT X N Operation", section 2.4.

*For detailed description of method used write for Data File 111, "How to Make Frequency Measurements".

Flow Measurements.* Flow measurements require a transducer which generates one pulse or signal cycle each time a certain volume of liquid passes a given point. By selecting the proper counting period a rate of flow indication can be obtained in any desired units. See "E/UT X N Operation", section 2.4. Total flow can also be indicated in any desired units using "B INPUT/N" operation. See section 2.6. Modification K will adapt instrument to input signals 5 ms in amplitude at 5 cps.

Tachometry.* Rotational rates can also be directly indicated in any units desired. See section 2.4, "E/UT X N Operation".

Measurement of Pressure, Temperature and Strain.* Transducers are available which generate an electrical signal with a frequency that changes in proportion to change in pressure, temperature or strain. When cycles of this signal are counted during a properly selected period of time, an indication can be obtained in any desired units.

Events Timing.** The instrument will time the interval separating two events represented by voltage excursions at the same or separate input jacks. See section 2.7, "PERIOD X N Operation", and section 2.8, "TIM Operation".

Viscosity and Ballistics Measurements.** The instrument can be used to measure the velocity with which an object falls through a liquid, or the velocity with which a projectile moves. This is done by measuring the time required to pass between two points, using transducers such as photocells which generate a signal as the points are reached. See section 2.8, "TIM Operation".

Phase Measurements. Phase differences can be measured by timing the interval between corresponding points on two waveforms. See section 2.8, "TIM Operation".

Use as a Preset Counter. The digital divider in the instrument can be used as a preset counter-controller which will produce an output signal after a preselected number of input cycles. See section 2.6, "B INPUT/N Operation".

Time Interval Generation. The instrument will generate sharp voltage pulses at an output jack. The pulse interval is precise and selectable over a wide range. See section 2.10, "TIG Operation".

Producing Time Delays. Used as a variable time delay generator, the instrument will produce an output pulse at a precise preselected interval after an input pulse is applied. See section 2.11, "DELAY Operation".

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*For detailed description of method used write for Data File 111, "How to Make Frequency Measurements".

**For detailed description of methods used write for Data File 112, "How to Make Time Interval Measurements".

Telemetry. Binary-coded signals representing the registered count are available at a rear panel connector. See section 2.1.12.

1.4 BECKMAN ACCESSORIES

Printers. Beckman printers are available to record the registered count in the form of decimal digits on a paper tape.

In-Line Readouts. Beckman in-line readouts display the registered count in large, red numerals made up of lighted segments. As the numerals are 1-1/4 inches high and lie in the same vertical plane, they can be easily read from a distance and at most angles.

Transducers. Various Beckman transducers have been designed to convert mechanical or optical events into electrical input signals.

2. OPERATION

2.1 CONTROLS, CONNECTORS & INDICATORS

This table is designed to supplement the step-by-step operating directions beginning with section 2.2 and continuing through section 2.11. The table includes auxiliary connectors but not controls used to adjust certain circuits when servicing the instrument. Those controls are listed in section 3.1.

2.1.1 FUNCTION Switch. Located on front panel. Interconnects major functional components to perform the operation indicated. See sections 2.4 through 2.11 for a description of each operation.

2.1.2 "A" Channel Controls and Connector. Located on the front panel, these are the triggering controls and input connector for the "A" input channel. See section 2.11 for input requirements and a description of how the controls operate. This input channel is used only for TIM and (A/B)N operation.

2.1.3 "B" Channel Controls and Connector. Located on the front panel, these are the triggering controls and input connector for the "B" input trigger channel. See section 2.11. This input channel is used for all operations except TIG.

2.1.4 TIME-MILLISECONDS Switch. Located on the front panel. The clock-pulse generator produces output signals at all the pulse intervals engraved around the switch. The switch selects the particular pulse interval which will be used. The pulse intervals engraved in red cannot be used if the clock-pulse generator is to drive the digital divider as it does during E/UT X N, TIG and DELAY operations.

2.1.5 Digital Divider Switches. These are four ten-position thumb switches located on the front panel and labeled "N". The switches may be set to any number from "0001" to "9,999" and the divider will divide its input pulse frequency by that number. Division occurs in such a way (by gating every Nth input pulse) that the result is to multiply the input pulse interval accurately.

2.1.6 Count Indication. Columns of digits located on the front panel. Illuminated digits indicate the registered count.

2.1.7 DISPLAY Time Control. Located on the front panel. The position of this control determines how long the count indication will persist before the instrument resets to a registered count of zero. If this control is rotated clockwise until a switch click is heard, the instrument will retain the indication until the RESET button is pressed. After resetting to zero, the instrument will begin counting again as soon as a "start counting" signal occurs.

2.1.8 RESET Button. Located on the front panel. Resets instrument to a registered count of zero when pressed.

2.1.9 SCOPE Jack. Located on rear panel. The voltage at this jack is about -45 v with respect to ground when the gate is closed, and at approximately ground level when the gate is open. An oscilloscope connected to this jack will display a square wave whose width corresponds to the length of time the gate is open, or in other words, to the counting period.

2.1.10 TIME Jack. Located on rear panel. See "TIG Operation".

2.1.11 FREQuency Jack. Located on rear panel. A sine wave signal at the oscillator frequency is available at this jack.

2.1.12 DIGITAL RECORDER Jack. Located on the rear panel, this jack makes available DCU readout data and control signals to operate such auxiliary equipment as printers, in-line display units, and data converters. The electrical readout is in 1-2-2-4 code, represented by two voltage levels shown as "0" (-15 volts or more negative with respect to ground) and "1" (ground level or more positive than ground) in the following table. Using the table to convert a coded digit to a decimal digit, you note the weight of each column in which a "1" appears, then sum the weights. For example, the coded digit "0110" is equivalent to 0+2+2+0 =4; and "1011" is equivalent to 1+0+2+4 =7.

1-2-2-4 Code

DECIMAL DIGIT REGISTERED	FIRST BINARY STAGE (Weight 1)	SECOND BINARY STAGE (Weight 2)	THIRD BINARY STAGE (Weight 2)	FOURTH BINARY STAGE (Weight 4)
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	1	1	0
5	1	1	1	0
6	0	0	1	1
7	1	0	1	1
8	0	1	1	1
9	1	1	1	1
No Digit	0	0	1	0

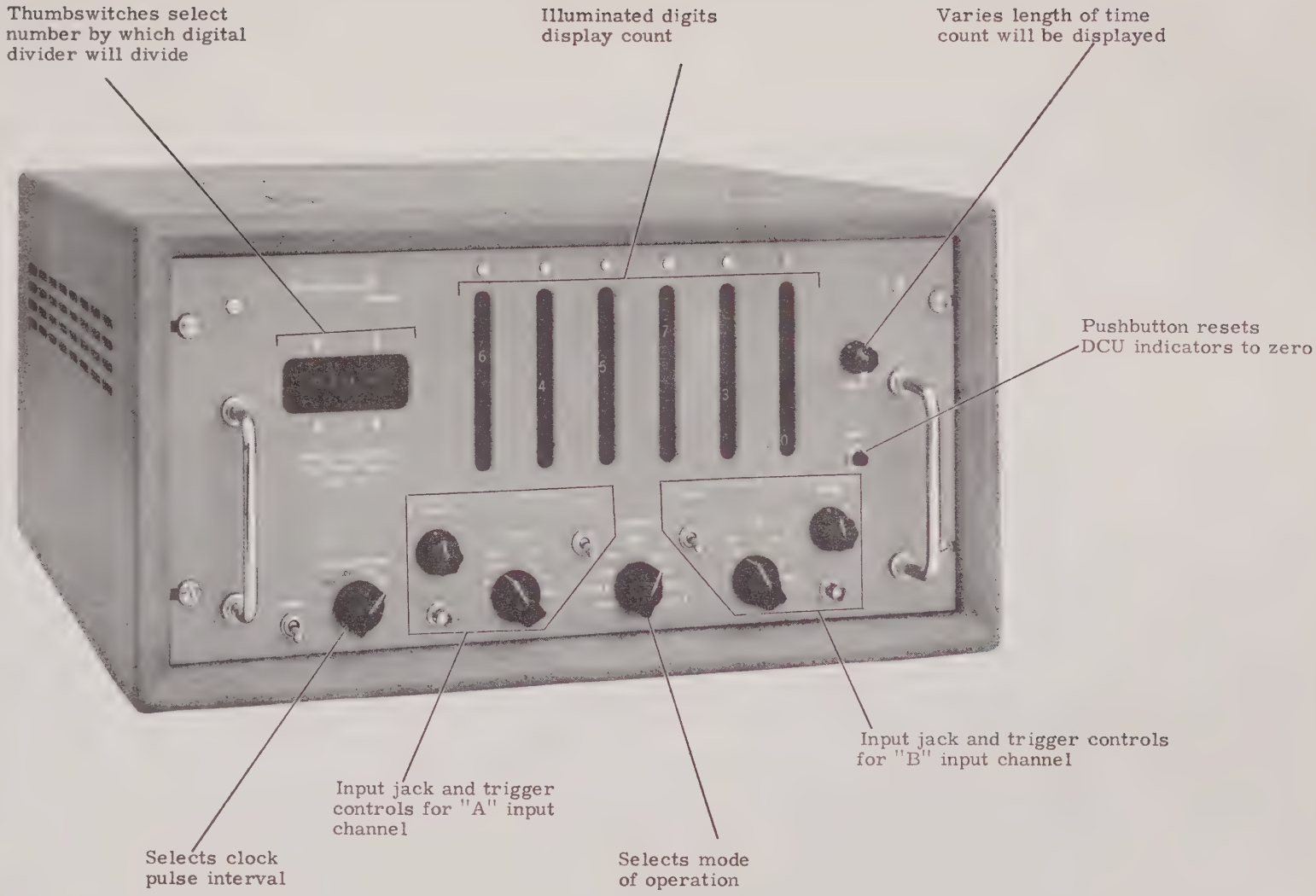

Thumbswitches select number by which digital divider will divide
Illuminated digits display count
Varies length of time count will be displayed
Pushbutton resets DCU indicators to zero
Input jack and trigger controls for "B" input channel
Input jack and trigger controls for "A" input channel
Selects clock pulse interval
Selects mode of operation

FIG. 1 OPERATING FEATURES OF MODEL 7361

Identification of Pin Numbers on Digital Recorder Socket

ORDER OF DIGIT READ	FIRST BINARY STAGE	SECOND BINARY STAGE	THIRD BINARY STAGE	FOURTH BINARY STAGE
Highest	Pin 4	Pin 3	Pin 2	Pin 1
Second	8	7	6	5
Third	12	11	10	9
Fourth	16	15	14	13
Fifth	20	19	18	17
Sixth **	24	23	22	21

Pin 39 carries a control signal from the counter. This pin is negative during the display period and positive from reset until the end of the next counting period.

Pin 40 is the "inhibit reset" line. When this pin is grounded the counter cannot reset.

Pins 30 (7351 only), 31, 32 and 38 are grounded. Pins 25 through 29, 30 (7361 only), and 33 through 37 are not used.

**On instruments containing only five DCU's these pins are permanently wired to produce the "no digit" code, 0010.

2.2 INSTALLING AND APPLYING POWER

The instrument may be located in nearly any convenient location. Simply plug the power cord into a source of line power, 117 v. ±10%, 50 to 60 cps. The Model 7351 draws 260 watts; Model 7361, 335 watts.

On the Model 7361, the oscillator crystal oven becomes energized as soon as the power cord is connected even though the POWER switch is off. Starting cold, the oven will bring the crystal to the correct, stable temperature within one hour. Only then will the instrument perform with maximum accuracy. Therefore, if the instrument is to be used intermittently, leave the power cord connected at all times to avoid waiting while the crystal oven warms. The power consumed by the crystal oven is negligible and no other circuitry is energized.

To energize the remaining circuitry, turn the POWER switch on. After a two-minute warmup, the instrument will be ready for use.

On the Model 7351, the crystal oven is not energized until the POWER switch is turned on. For stable operation of the oscillator, therefore, the proper warmup period should be allowed.

2.3 TESTING FOR PROPER OPERATION

With the FUNCTION switch at TEST, the instrument counts cycles of the crystal oscillator frequency for a period equal to the TIME MILLISECONDS switch setting multiplied by the number to which the digital divider switches are set. To test the multivibrator frequency dividers and the high-speed decimal counting units, proceed as follows:

1) Place the FUNCTION switch at TEST. The SLOPE switch may be at either position.

2) Set the digital divider switches (labeled N) to indicate "0001".

3) Adjust the DISPLAY time control so that the illuminated count indication on the front panel will persist long enough to be read conveniently. Note that if the DISPLAY control is turned clockwise until a switch click is heard, the count indication will persist until the RESET button is pressed. At all other positions the indication will remain displayed for 0.1 to 10 seconds, depending on the setting. The instrument will then reset to zero automatically and begin another counting period.

4) Place the TIME MILLISECONDS switch successively at every setting except the smallest and note the count indication at each position. The count indications should be as listed in the following table.

TIME Switch Position	Correct Count Indication Model 7351	Model 7361
.001		1
.01	Any	10
0.1	10	100
1.0	100	1000

If incorrect indications appear, adjust the multivibrator frequency dividers as descirbed in section 3.1.2.

To test digital divider and the remaining decimal counting units, turn the TIME switch to 0.1 ms, then, setting each preset switch at each of its ten possible positions, observe the count indication at each position. Follow the table below.

Digital Divider Switch Setting (N)				Correct Count Indication	
1,000's	100's	10's	1's	Model 7351	Model 7361
0	0	0	1	10	100
0	0	0	2	20	200
0	0	0	3	30	300
0	0	0	4	40	400
0	0	0	5	50	500
0	0	0	6	60	600
0	0	0	7	70	700
0	0	0	8	80	800
0	0	0	9	90	900
0	0	1	0	100	1,000
0	0	2	0	200	2,000
0	0	3	0	300	3,000
0	0	4	0	400	4,000
0	0	5	0	500	5,000
0	0	6	0	600	6,000
0	0	7	0	700	7,000
0	0	8	0	800	8,000
0	0	9	0	900	9,000
0	1	0	0	1,000	10,000
	thru				
0	9	0	0	9,000	90,000
1	0	0	0	10,000	100,000
	thru				
9	0	0	0	90,000	900,000

2.4 "E/UT X N" OPERATION

How Components are Interconnected. The output of the clock-pulse generator is fed to the digital divider, thus obtaining pulses separated by some multiple (1 to 9,999) of the clock-pulse interval. These pulses actuate the gate control circuitry, causing the gate to open for the length of time separating successive pulses. During this interval pulses from the "B" input channel pass through the gate and are counted. The "A" input channel is not used during this operation.

What Kind of Measurement is Made. With the FUNCTION switch positioned at E/UT X N, the instrument will count cycles of the signal at the "B" input for a period equal to the TIME-MILLISECONDS switch setting multiplied by N, the number indicated by the digital divider switches. For example, with the TIME-MILLISECONDS switch at 1.0 and the divider switches set to indicate "4168", the instrument will count for exactly 4,168 milliseconds. In this case the count indication would be 4,168 times the indication obtained with a counting period equal to the TIME switch setting; hence, the designation "E/UT X N". Furthermore, using the SCAN position of the FUNCTION switch as described under "SCAN Operation" below, the counting period may be manually extended to any multiple of the automatic counting period selected under E/UT X N operation. Maximum input frequency is 100 Kcs in the case of Model 7351, and 1 Mcs in the case of Model 7361.

Operating Characteristics.

Input Frequency Range:	Model 7351: d-c to 100 Kcs Model 7361: d-c to 1 Mcs
Other Input Requirements:	See Section 2.12
Length of Counting Period:	May be varied from 0.1 milliseconds to 1000 milliseconds in steps of one-tenth of a millisecond. May be varied from 1000 milliseconds to 9,999 milliseconds in one-millisecond steps.
Accuracy:	±one cycle ± accuracy of crystal oscillator frequency. (See section 1.2)
Maximum Number of Cycles Registered:	Model 7351: 99,999 Model 7361: 999,999

Operating Procedure.

(1) Place the FUNCTION switch at E/UT X N. The SLOPE switches may be at either position.

(2) Place the TIME-MILLISECONDS switch at 0.1 or 1.0 milliseconds. IMPORTANT NOTE: The instrument will not perform this operation with the TIME-MILLISECONDS switch at .01 or .001 ms.

(3) Set the digital divider switches to a number which, when multiplied by the TIME switch indication, will equal the desired counting period.

4) Couple a signal to the "B" input jack and adjust the ATTENuation and TRIGGER controls as described under section 2.12 "Input Adjustments".

5) Adjust the DISPLAY time control for a convenient reading.

2.5 "SCAN" OPERATION

How Components are Interconnected. This is a variation of "E/UT X N" operation. The operator uses a front-panel switch to disconnect the digital divider from the gate control circuitry after the gate has been opened by an initial pulse. Consequently, the gate will remain open until the divider is reconnected. The total counting time then becomes some multiple of the output pulse interval from the divider.

Purpose. Using this mode of operation, the operator can manually extend the total counting period to any multiple of the automatic counting period selected under E/UT X N operation. For example, if you want the instrument to count for 60 seconds, you might select a five-second automatic counting period under E/UT X N operation, then allow the instrument to count for 12 five-second periods.

Operating Procedure.

1) Follow steps 1 thru 4 of section 2.4, "E/UT X N OPERATION".

2) Rotate the DISPLAY time control clockwise to a stop, but not so far that a switch clicks.

3) The instrument will begin cycling. It will count for the automatic period selected under E/UT X N operation, hold the count indication for about five seconds then return to zero and begin counting again. Interrupt one of these cycles as follows: as the instrument starts counting, quickly turn the FUNCTION switch to SCAN and simultaneously begin timing a period equal to the total counting time desired less one automatic counting period. For example, if the total counting time desired is 60 seconds (12 five-second periods), the interval to be timed is 55 seconds. At the end of this period, turn the FUNCTION switch back to E/UT X N. When the instrument stops counting, turn the DISPLAY control clockwise until a switch click is heard; this will hold the count indication until it can be read.

4) To obtain the input frequency in cycles per second, divide the count indication by the total counting interval in seconds.

2.6 "INPUT/N" OPERATION

How Components are Interconnected. To perform this function, the pulse output of the "B" input channel is applied to the digital divider. With the gate open

at all times, the operator connects the divider output to the gate with a front-panel switch. Neither the clock-pulse generator nor the "A" input channel is used.

What Kind of Measurement is Made. With the FUNCTION switch at INPUT/N the instrument divides the frequency at the "B" input jack by N, (the number indicated by the digital divider switches) then counts cycles of the resulting lower frequency signal. For example, with a 10 Kcs signal at the "B" input and the divider switches set to "0250", the instrument counts cycles of a 40 cps signal. Note that the counting rate is equal to the "B" input frequency divided by N; hence, the designation "INPUT/N".

Since the output of the digital divider is available at the TIME jack, the instrument also functions as a preset controller, delivering an output pulse each time N cycles occur at the B input jack. The output consists of negative pulses, approximately 3 v. high and 12 microseconds wide out of 100 ohms, capacitively coupled to the jack.

Operating Characteristics.

Input Frequency Range:	d-c to 10 Kcs
Other Input Requirements:	See section 2.12
Range of N:	Any number from one to 9,999
Maximum Number of Counts Registered:	Model 7351: 99,999 Model 7361: 999,999

Operating Procedure.

(1) Couple a signal to the "B" input jack and adjust the corresponding ATTENuation and TRIGGER controls as described in section 2.12, "Input Adjustments".

(2) Place the FUNCTION switch at OFF, and press the RESET button. (The SLOPE switch may be at either position.)

(3) Set the digital divider switches (labeled N) to the number by which the input frequency is to be divided.

(4) Rotate the FUNCTION switch to INPUT/N to start counting.

(5) Turn the FUNCTION switch to OFF to halt counting. Counting may be resumed without clearing the accumulated count indication by turning the switch back to INPUT/N.

(6) To clear the registered count, press the RESET button.

2.7 "PERIOD X N" OPERATION

How Components are Interconnected. The output of the clock pulse generator is applied to the gate so that clock pulses will be counted whenever the gate is open. The gate is opened by a pulse from the "B" input channel and closed

by a pulse from the digital divider, driven in turn by the B input channel. The A input channel is not used.

What Kind of Measurement is Made. With the FUNCTION switch at PER X N the instrument operates as a timer. It times the interval between the first voltage excursion through a selected level at the "B" input and the Nth following excursion of the same polarity, where N is the number set on the digital divider switches. For example, assume that the input is a cyclic signal, the divider switches are set at "1000" and the B SLOPE switch is set to "+". Under these conditions the instrument begins registering time at the first positive input excursion, continues timing for 999 additional excursions, and stops timing at the 1000th positive excursion. The count indication then shows the time elapsed while 1000 input cycles have occurred. Note that this indication will be 1000 times the average period of the input signal; hence, the designation "PER X N".

Operating Characteristics.

Input Frequency Range:	d-c to 10 Kcs
Other Input Requirements:	See section 2.12
Range of N:	Any number from one to 9,999

Units in which Measurement Appears: Choice of milliseconds, tenths of a millisecond, hundredths of a millisecond and (with Model 7361 only) microseconds.

Maximum Measurable Interval:	Model 7351:	99,999 time units.
	Model 7361:	999,999 time units.

Accuracy. Accuracy depends somewhat on the amount of noise on the input signal. With a noiseless signal, possible error is ± one time unit ± accuracy of crystal oscillator frequency. With a large N (1000, for example) noise will not affect accuracy appreciably.

Operating Procedure.

(1) Place the FUNCTION switch at PER X N.

(2) Set the digital divider swithces (labeled "N") to the number of cycles to be timed.

(3) Set the TIME-MILLISECONDS switch to the time unit in which the measurement is to appear.

(4) Position the B SLOPE switch to trigger on either the positive-going (+) or negative-going (-) portions of the input waveform. Choose the steeper of the two slopes if there is any difference.

(5) Couple a signal to the "B" input jack and adjust the corresponding ATTENuation and TRIGGER controls as described under "Input Adjustments", section 2.12.

2.8 "TIM B-A" OPERATION

How Components are Interconnected. The output of the clock-pulse generator is applied to the gate so that clock pulses will be counted during the period the gate is open. Both input channels are coupled to the gate control circuitry. The gate is opened by a pulse from the B input channel and closed by a pulse from the A input channel. The digital divider is not used in this operation.

What Kind of Measurement is Made. With the FUNCTION switch at TIM B-A, the instrument operates as a timer. It times the interval between the voltage excursion through a selected level at the B input jack and a later excursion through an independently selected level at the A input jack. Excursions may be of the same or different polarities and amplitudes.

Operating Characteristics.

Units in which Measurement Appears: Choice of milliseconds, tenths of a millisecond, hundredths of a millisecond and (with Model 7361 only) microseconds.

Maximum Measurable Interval: Model 7351: 99,999 time units
Model 7361: 999,999 time units

Accuracy: ±one time unit ±accuracy of crystal oscillator frequency.

Operating Procedure.

(1) Set the FUNCTION switch to TIM B-A.

(2) Set the TIME-MILLISECONDS switch to the time unit in which the measurement is to appear.

(3) Couple the start signal to the "B" channel input jack, and the stop signal to the "A" channel input jack.

(4) For each input, set the corresponding SLOPE switch to "plus" (+) if the voltage excursion is positive, or to "minus" (-) if the excursion is negative, and adjust the ATTENuation and TRIGGER controls. The effect of these controls is described in section 2.12, "Input Adjustments".

(5) As soon as a voltage excursion of the proper polarity occurs at the B input jack the instrument will start timing. It will stop timing whenever a subsequent excursion occurs at the A input jack.

(6) The time indication will appear in the unit indicated by the TIME-MILLISECONDS switch. For example, if the lighted numerals read "6257" with the TIME-MILLISECONDS switch at .01, the time interval is 62.57 ms.

2.9 "A/B X N" OPERATION

How Components are Interconnected. The pulse output of the A input channel is applied to the gate to be counted during the period the gate is open. The gate control circuitry is actuated by the digital divider which, in turn, is driven by pulses from the B input channel.

What Kind of Measurement is Made. With the FUNCTION switch at A/B X N, the instrument counts each cycle of the signal at the A input during a preselected interval. This is the interval between a voltage excursion through a selected level at the B input and the Nth following excursion of the same polarity, where "N" is the number set on the digital divider switches. For example, assume the divider switches are set to "1000", and the SLOPE switch is set at "+". Under these conditions, the instrument starts counting with a positive-going B input excursion, continues counting for 999 additional excursions, and stops counting with the 1000th positive-going excursion. The count indication then shows the number of "A" input cycles which have occurred during 1000 "B" input cycles. Note that this would be 1000 times the ratio of the A input frequency to the B input frequency; hence, the designation "A/B X N".

Operating Characteristics.

"A" Input Frequency Range:	Model 7351: d-c to 100 Kcs. Model 7361: d-c to 1 Mcs.
"B" Input Frequency Range:	d-c to 10 Kcs.
Other Input Requirements:	See section 2.12.
Range of N:	Any number from one to 9,999.

Operating Procedure.

(1) Set the FUNCTION switch to A/B X N.

(2) Position the digital divider switches (labeled "N") to indicate the number of B input cycles during which counting is to take place. For example, if the "A" input is to be counted for the period of 1,526 "B" input cycles, set the switches to read "1526".

(3) Couple the signal to be counted to the "A" input jack. Couple the signal which is to start and stop the counting process to the "B" input jack. The A SLOPE switch may be at either position. Ordinarily the B SLOPE switch may be at either position also. If at "+" positive-going excursions start and stop the counting action; if at "-", negative-going excursions are effective. Adjust the ATTENuation and TRIGGER controls for each input. Instructions for adjusting these controls appear in section 2.12, "Input Adjustments".

2.10 "TIG" (TIME INTERVAL GENERATOR) OPERATION

With the FUNCTION switch at TIG the instrument does not operate as a measuring device. Instead, the clock-pulse generator drives the digital divider, which then generates pulses for external use. The pulse interval is precise and may be varied over a wide range. The pulses appear at the TIME jack located at the rear of the instrument. The pulse interval will be equal to the TIME-MILLISECONDS switch setting (0.1 or 1.0 ms) multiplied by N, the number to which the digital divider switches are set. This makes it possible to obtain pulse intervals ranging from 0.1 to 1000 milliseconds in steps of a tenth of a millisecond and from 1000 ms to 10,000 ms in steps of one millisecond. The .01 ms or .001 ms positions of the TIME switch cannot be used in this operation.

The signal at the TIME jack will consist of negative pulses approximately 12 microseconds wide and approximately 3 volts high. The output impedance is approximately 100 ohms. Because the jack is capacitively coupled to the pulse-forming circuitry, there is no d-c output level. The leading negative transient has a faster rise time than the positive recovery transient. It is recommended that the negative transient be used when a highly accurate time standard is required.

2.11 "DELAY" OPERATION

In this mode, the instrument acts as a time delay generator. It provides a variable time delay ranging from 0.1 to 1000 ms in steps of 0.1 ms and from 1000 to 9,999 ms in steps of 1 ms.

Operation is similar to that of "TIG". In this case, however, a single output pulse appears at the TIME jack after a "start" signal has been applied to the "B" input jack and the preselected interval has elapsed. The time interval is produced by the clock pulse generator driving the digital divider. The clock pulse generator also drives the indicating DCU's so that the time delay will be displayed.

Accuracy. Although the maximum possible timing error is 0.1 ms or 1 ms, depending on the setting of the TIME-MILLISECONDS switch, the DCU indicators will always show the actual time delay obtained to within ±10 microseconds on the Model 7351, and ±1 microsecond on the Model 7361.

Operating Procedure.

(1) Set the FUNCTION switch to DELAY.

(2) Set the digital divider switches (labeled N) and the TIME-MILLISECONDS switch for the required time delay. The delay interval will be equal to the TIME-MILLISECONDS setting (0.1 or 1.0 ms) multiplied by the number to which the divider switches are set.

(3) Apply a "start" signal to the "B" input jack. The SLOPE switch may be set to either "plus" (+) or "minus" (-), depending on whether the positive-going or negative-going part of the start signal is to begin the delay.

(4) At the end of the delay period, an output pulse will appear at the TIME jack at the rear of the instrument, and the time delay will be displayed by the DCU indicators.

2.12 INPUT REQUIREMENTS AND ADJUSTMENTS

2.12.1 Function of Controls. There are two input channels; the "A" channel and the "B" channel. The controls affecting each channel are grouped with the corresponding input jack under the letters "A" and "B".

The attenuator divides the input voltage by the factor to which the ATTENuation control is set. With this control on the "DC" side, the signal is directly coupled to the trigger circuitry; in which case the circuit will trigger regardless of how slowly the input voltage changes. With the ATTENuation control on the "AC" side, the input signal is capacitively coupled to the trigger circuits; in this case the input frequencies must be 5 cps or higher, unless the input signal is strong enough to overcome the attenuating effect of the coupling capacitor.

The TRIGGER control varies the instantaneous voltage at which the attenuated signal triggers the input circuit. This critical voltage may be varied continuously from -1 v. to +1 v.

2.12.2 Input Requirements. Input excursions must be at least 0.3 volts in amplitude. This means that an a-c signal 0.3 volts peak-to-peak (100 millivolts rms) will trigger the input channel successfully. An input attenuation control is provided to attenuate the input voltage by a factor of 10 or 100 thus decreasing the sensitivity to 3 or 30 volts peak-to-peak respectively. Noise below peak-to-peak sensitivity will not trigger an input channel; therefore, it is desirable to set the sensitivity at a point between signal amplitude and noise amplitude. Maximum input frequency depends upon the mode of operation. See instructions on the mode of operation being used.

The position of the SLOPE switch determines whether a positive-going or a negative-going input excursion will trigger the pulse which affects succeeding circuitry. Instructions for positioning the SLOPE switch appear in the directions for each mode of operation.

2.12.3 How to Adjust the B Input Channel. When the input is a cyclic signal with a frequency above 5 cps, follow the step-by-step procedure given below. This procedure will result in successful operation in nearly all cases.

(1) Couple a signal to the B input jack.

(2) Set the digital divider switches to "0001".

(3) Place the FUNCTION switch to OFF, then turn it to INPUT/N.

(4) Rotate the TRIGGER control slowly from one extreme to the other while the ATTENuation control is at each of the three settings on the AC side.

Note that the instrument will count steadily over a certain range of the TRIGGER control for each ATTENuation setting. Choose the highest ATTENuation setting at which counting will continue when the TRIGGER control is rotated through at least 45 degrees.

(5) Position the TRIGGER control at the midpoint of the arc throughout which counting occurs.

2.12.4 How to Adjust the A Input Channel. If the input is an a-c signal with a frequency above 5 cps, follow the step-by-step procedure given below. This procedure will result in successful operation in nearly all cases.

(1) Set the FUNCTION switch to A/B X N.

(2) With no signal coupled to the B input set the B channel controls as follows:

(a) ATTENuation control at 1 on the DC side.

(b) TRIGGER control at the extreme counterclockwise position.

(3) Turn the DISPLAY control clockwise until a switch clicks and press the RESET button.

(4) Rotate the B TRIGGER control fully clockwise and back again to the extreme counterclockwise position. At this point the electronic gate will be open so that the instrument will count the cycles of a signal introduced at the A input provided the A channel controls are properly adjusted.

(5) Couple the signal to the A input jack.

(6) Rotate the A TRIGGER control slowly from one extreme to the other while the ATTENuation control is at each of the three settings on the AC side. Note that the instrument will count steadily over a certain range of the TRIGGER control for each ATTENuation setting. Choose the highest ATTENuation setting at which counting will continue when the TRIGGER control is rotated through at least 45 degrees.

(7) Position the TRIGGER control at the midpoint of the arc throughout which counting occurs.

3. SERVICING

WARNING

210 volts d-c is present on the terminals of the four digital divider switches, located behind the front panel on the left-hand side. This voltage is capable of delivering a severe electrical shock; therefore, be careful not to touch these switches when making any of the adjustments described below.

3.1 ADJUSTMENTS

3.1.1 All adjusting controls and test jacks can be exposed to view by removing the lid of the cabinet. A few controls may be located on the rear panel. An identifying label appears near each control or jack. These labels appear in capital letters in the directions below.

CAUTION

Removing the cabinet lid impairs the forced-draft ventilation system. Therefore, to avoid over-heating, do not permit the instrument to operate very long with the lid removed.

3.1.2 Multivibrator Frequency Divider Controls. (Labeled "10^{-3} SEC., 10^{-4} SEC., and 10^{-5} SEC.) The position of these controls determines whether the dividers will divide correctly (by 10) or incorrectly (by 9 or 11). The controls should be adjusted whenever the instrument fails to give a correct indication when tested for proper operation using the TEST position of the FUNCTION switch. The line voltage during adjustment should be either exactly 117 v. (in which case the adjustment will hold for line variations of ±10%) or the actual average line voltage on which instrument is to be operated. Each control should be adjusted while measuring the d-c voltage at the red test jack near it. Rotate each control back and forth to the extremes of the range in which a correct count indication appears, noting the test jack voltage at each extreme. Then position the control so that the test jack voltage is midway between the extreme values. Follow the table below.

	Model 7351			Model 7361		
	Place TIME MILLISECONDS Switch at	Adjust	Correct Count Indication	Place TIME MILLISECONDS Switch at	Adjust	Correct Count Indication
Step 1	0.1	10^{-4}SEC	10	.01	10^{-5}SEC	10
Step 2	1.0	10^{-3}SEC	100	0.1	10^{-4}SEC	100
Step 3	---	---	---	1.0	10^{-3}SEC	1000

For example, step 1 when adjusting the Model 7351 should be done as follows:

Place the FUNCTION switch at TEST and the TIME-MILLISECONDS switch at 0.1. Measure the d-c voltage with respect to ground at test jack E4 near the control labeled "10^{-4}SEC". Rotate the control until the count indication changes from "10" to "9" and note the test jack voltage at this point. Then, rotate the control in the opposite direction until the count indication changes from "10" to "11", noting the test jack voltage at this point also. Finally, position the control at a point where the test jack voltage is halfway between the values noted. For example, if the voltage reading was +72 v. as the count indication changed from "10" to "9" and +94 v. as indication changed from "10" to "11", set the control so the test jack reading is +83 v.

3.1.3 How to Adjust the Regulated B+ Supply. Adjust the "+120V ADJUST" control (located at the rear of the instrument) until the voltage at the "+120" test jack (located on top of the chassis) is +120 volts with respect to ground. The adjustment should be accurate to within ±3%. The line voltage while this adjustment is being made should be either the average line voltage on which the instrument will be operated or exactly 117 v. In either case the adjustment will hold for line voltage variations of ±10%.

3.1.4 Oscillator Frequency Control. This is a screwdriver adjustment point labeled "XTAL ADJ". Rotating it varies the oscillator frequency slightly. On the Model 7351 the 100 Kcs oscillator frequency has been adjusted to within 1 part in 10^6 at the factory; on Model 7361 the 1 Mcs frequency has been adjusted to within 1 part in 10^7. Do not disturb the control unless a frequency standard at least as accurate as the original setting is available. If you have a standard frequency signal, use it to form a Lissajous pattern with the oscillator signal which appears at the FREQuency jack. Couple the signal at the FREQ jack to the vertical input of a scope. Be sure the scope input impedance is not less than 10 megohms in parallel with 15 $\mu\mu$f; otherwise, the oscillator may be loaded enough to change its frequency slightly. Then, couple the standard frequency to the horizontal input and adjust the XTAL ADJ for a Lissajous pattern indicating equal frequencies.

3.1.5 Shaper Trigger Level Control. This is a screwdriver adjustment point located on top of the oscillator subchassis and labeled "SHAPER LEVEL". To adjust, position the FUNCTION switch at TEST. Find the limits of the range of adjustment over which the instrument continues to count. Set the control at the center of this range.

3.1.6 Trigger Voltage Control for Time Trigger Circuit. This control exists only on Model 7361. It is a screwdriver adjustment labeled "TIME TRIGGER LEVEL". The control varies the instantaneous input voltage at which the time trigger circuit (V601) switches states. Do not disturb the setting unless absolutely necessary. When necessary, adjust as follows. Position the TIME-MILLISECONDS switch at .001. With the FUNCTION switch at TEST, adjust the control until the instrument shows a count indication of "1". Then, move the TIME-MILLISECONDS switch to .01, 0.1 and 1.0 successively, observing the count indications at these positions. If correct indications do not appear, readjust the control until a correct indication appears at all four positions.

4. CIRCUIT DESCRIPTION

4.1 GATE AND CONTROL CIRCUITRY

(Refer to dwgs. 7351 D 1, and 7361 D 2.)
The Gate and Control Circuitry receive three pulse inputs from the FUNCTION switch (S201): pulses to be counted, start pulses and stop pulses. Pulses to be counted go from Deck G to the signal grid of the Gate tube (V204). The plate of this tube is coupled to the first of the cascaded DCU's. During the period its suppressor grid is at ground the tube amplifies the grid signal and drives the DCU's. In this state the Gate is "open". When the suppressor grid is below -10 volts, the tube is cut off and the Gate may be considered "closed".

The "open-close" voltages on the Gate tube suppressor grid are generated at the right plate of the Control Binary (V203). V203 is a conventional "flip-flop" circuit. Such a circuit has two stable states: left half conducting, right half cut off; and right half conducting, left half cut off. Input pulses or transients applied at various points on the circuit will trigger it back and forth between the two states. When the right half of V203 is conducting, the right plate is 30 volts negative. A negative start transient from the Start Binary, applied at the left plate of V203 and coupled through C210 to the right grid, triggers V203 to its other stable state. In this state the right half is cut off and the right plate rises above ground permitting the Gate tube to conduct. When a negative stop pulse from Deck E of the FUNCTION switch reaches the left grid of V203 through the diode CR212, V203 is triggered back to the state which holds the Gate closed.

The signals generated by V203 are also used to control the Input Gate (V701) and the Coincidence Gate (V702B) in the digital divider circuit.

The Start Binary is also a "flip-flop" circuit. It produces a negative start transient at its right plate each time that half begins to conduct. Its left grid is coupled to Deck C of the FUNCTION switch through the diode CR211 and C201. When the left half is conducting a negative start pulse at the grid triggers a change to the other stable state producing the output transient. Further negative pulses at the left grid have no effect since that half is already cut off.

When the instrument is ready to begin a counting period the right half of the Control Binary and the left half of the Start Binary are conducting and the Gate is closed. Negative stop pulses received at the left grid of the Control Binary have no effect since this half is cut off. The following sequence occurs. (Refer to Figures 2 and 3.)

At time "1" — A start pulse passes through the injection diode CR211 and triggers the Start Binary which in turn triggers the Control Binary to a state which opens the gate. The DCU's then count and indicate the number of pulses reaching the Gate.

At time "2" — A stop pulse triggers the Control Binary to a state which closes the Gate.

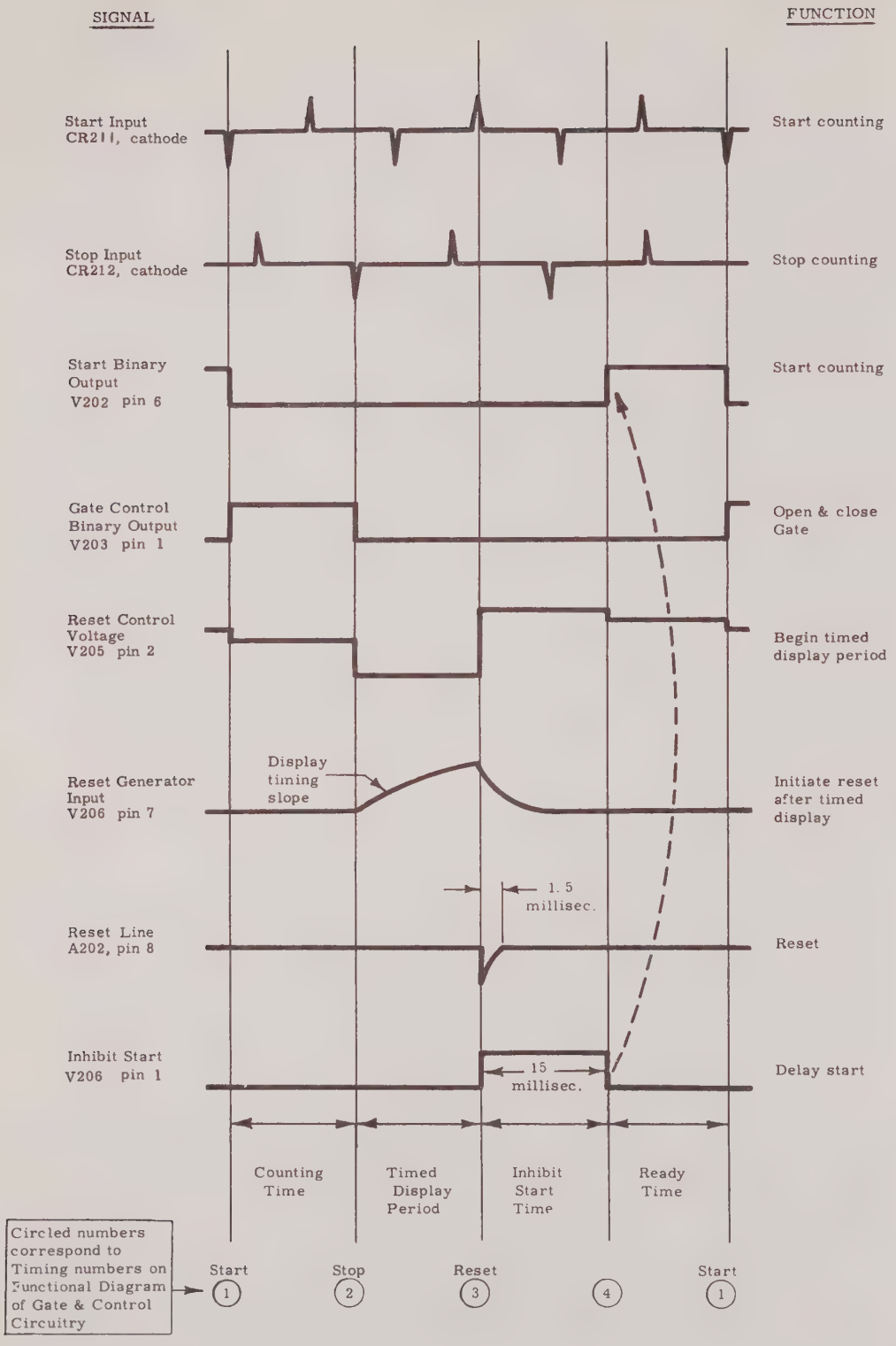
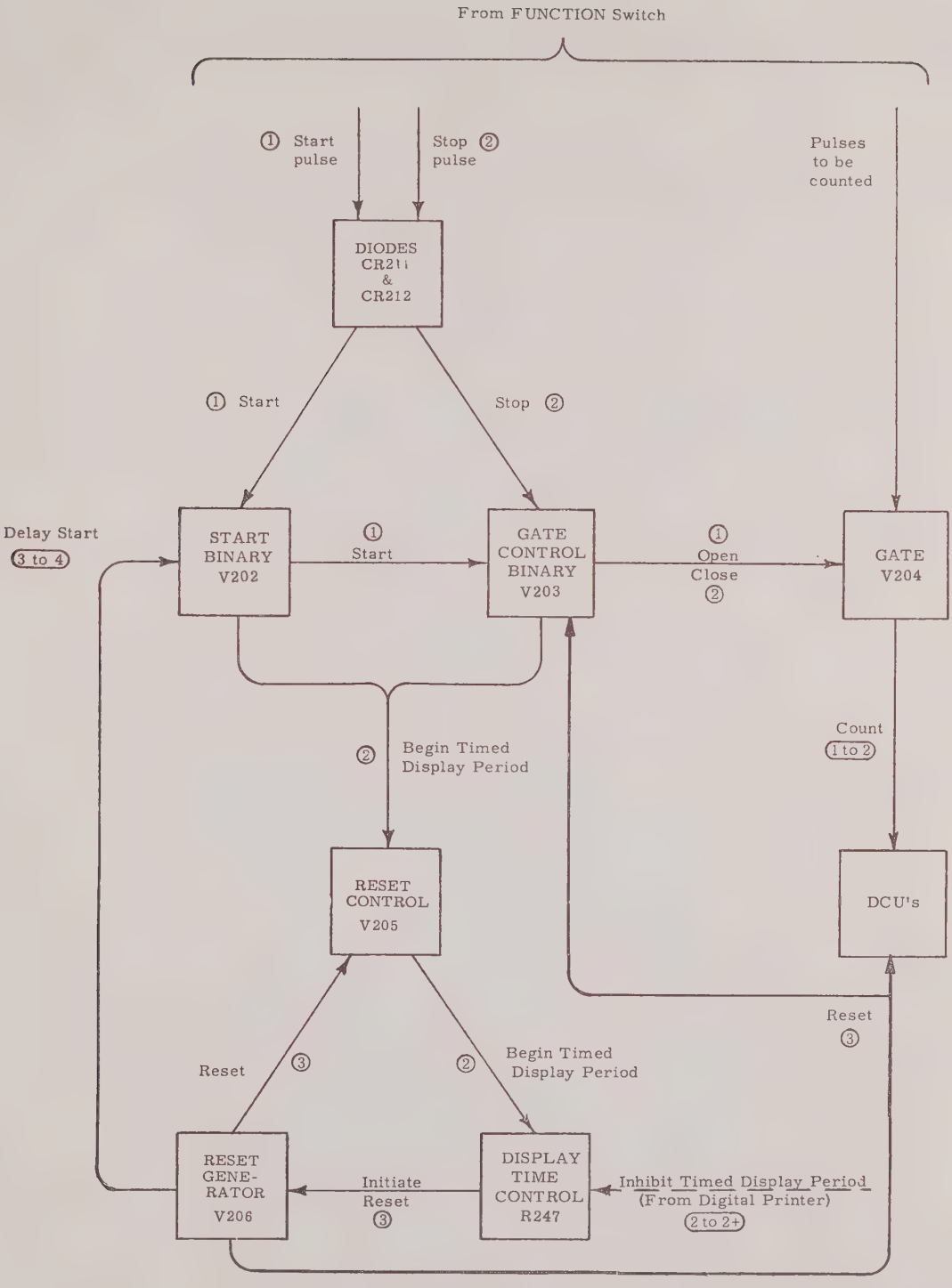


FIG. 2 CONTROL CIRCUIT TIMING DIAGRAM WHEN COUNTER IS NOT EQUIPPED WITH DIGITAL PRINTER



NOTE: Circled numbers indicate time of operation as labeled on the Timing Diagrams.

FIG. 3 FUNCTIONAL BLOCK DIAGRAM OF GATE AND CONTROL CIRCUITS

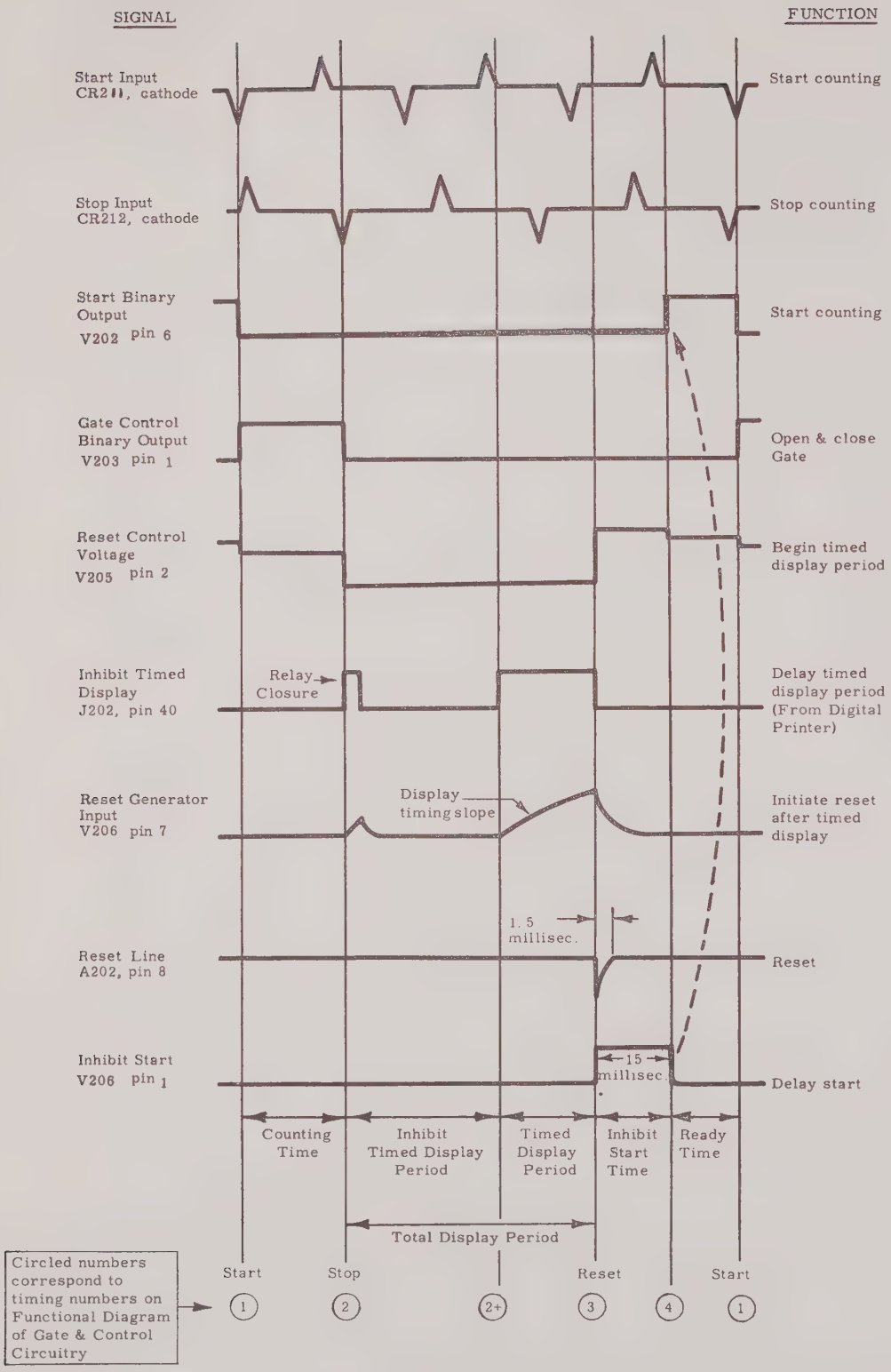


FIG. 4 CONTROL CIRCUIT TIMING DIAGRAM WHEN COUNTER IS EQUIPPED WITH DIGITAL PRINTER

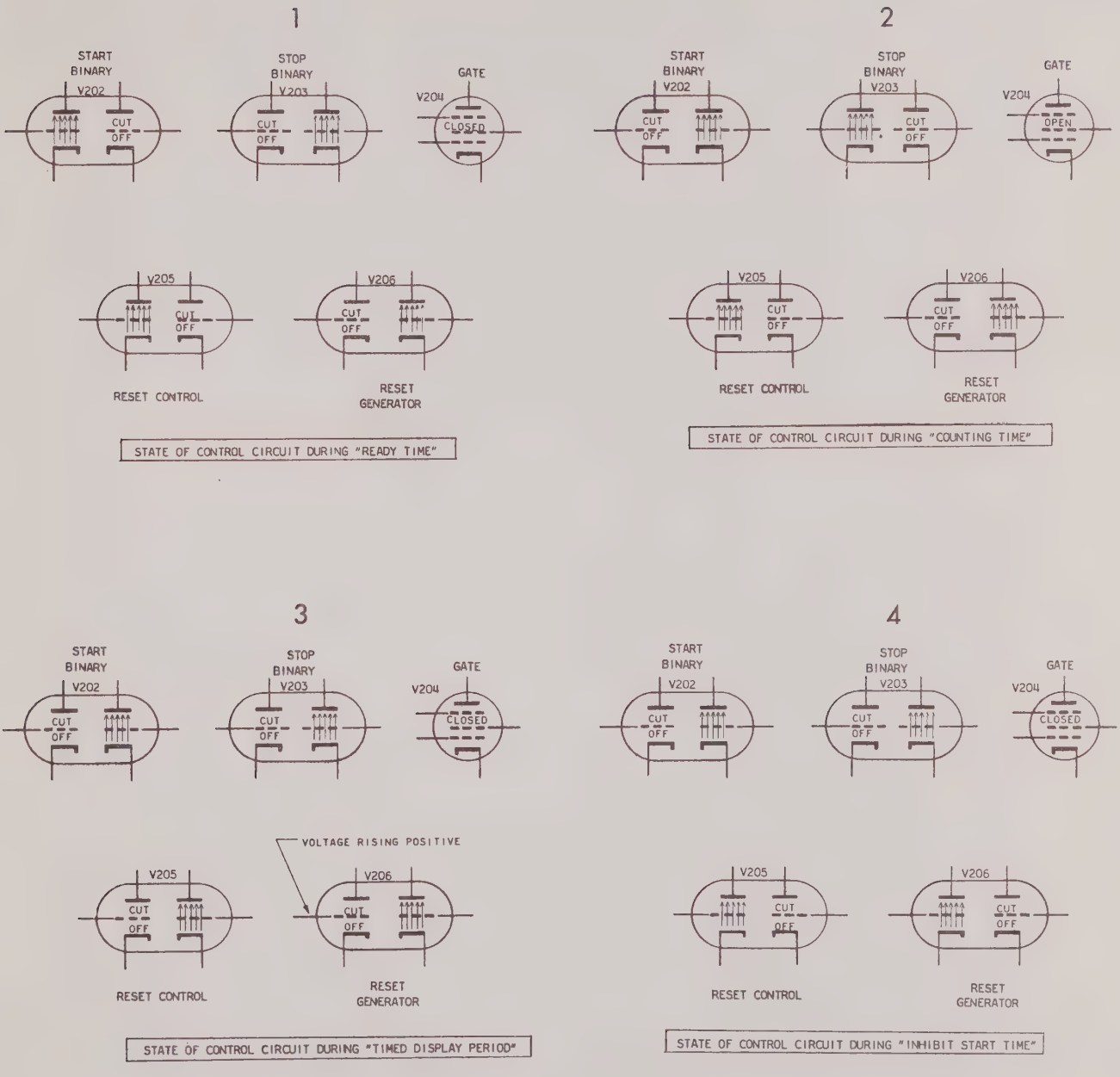


FIG. 5 STATE OF THE TUBES IN THE GATE AND CONTROL CIRCUITS DURING AN OPERATING CYCLE

At this point, if the instrument is set to operate automatically, the reset circuitry begins to function. The reset control voltage appears at the junction of CR201 and CR203. Its value is determined by the combined effect of the voltage on the right plate of the Start Binary and that on the right plate of the Gate Control Binary. At the close of a counting period (and only then) both these plates are negative. The resulting negative voltage at the junction is applied to the input grid of the Reset Control through R239.

This negative voltage biases the left-hand section of V205 to cutoff which, in turn, causes the right-hand section to conduct. The resulting rise in potential at the junction of resistor R248 and the DISPLAY time potentiometer (R247) causes capacitor C216 to discharge through R247. As the capacitor discharges, the potential at the input grid (pin 7) of the Reset Generator (V206) rises. The Reset Generator is a monstable multivibrator. In its stable state, the right-hand triode section is conducting while the left-hand section is cut off. When the potential on the left-hand grid becomes sufficiently positive, it triggers the Reset Generator to its quasi-stable state(i.e., left side conducting, right side cut off). This occurs at time "3", with the interval between time "2" and time "3" depending on the setting of the DISPLAY control (R247).

At time "3" then, the potential at the left-hand plate of the Reset Generator drops, while that at the right-hand plate goes up. The drop in voltage at the left-hand plate, coupled through a capacitor to the DCU reset line, produces a negative pulse which resets the DCU's. This same reset pulse also goes to the input grid (pin 7) of the Control Binary and triggers it to the "right side on" state. The rise in voltage at the right-hand plate of the Reset Generator is fed back to the input grid of the Reset Control. This causes it to return to its original state (i.e., left side on, right side off).

The Reset Generator remains in its quasi-stable state for 15 milliseconds. At the end of that period, time "4", the Reset Generator jumps back to its stable state (right side on, left side off), and the voltage on the right-hand plate drops. This drop in voltage is coupled through capacitor C203 and resistor R289 to the Start Binary, resetting it to the "left side on" state. The 15 millisecond delay provided by the Reset Generator keeps any start pulses from triggering the Start Binary, to initiate counting, until all reset transients have decayed.

When the Start Binary is reset, the potential on its right-hand plate goes up. The reset control line is clamped to this higher potential by diode CR201 so that the Reset Control (V205) will not be triggered at this time. The next start pulse triggers the Start Binary to its "right side on" state which, in turn, triggers the Control Binary to its "left side on" state. To prevent reset action at this time, diode CR203 clamps the reset control line to the relatively high positive potential at the right-hand plate of the Control Binary. The next stop pulse triggers the Control Binary to its "right side on" state, the potential at the right-hand plate drops, and the entire reset process is repeated.

NOTE: When the counter is equipped with the Model 1452 Digital Recorder, the sequence of operations described above is interrupted briefly. A relay in the recorder grounds the input to the DISPLAY time potentiometer from the end of the counting period (time "2") until the recorder has collected count information from the DCU's. (See Figure 4.) The connection to the recorder is made through pin 40 of J202.

When the DISPLAY time control is turned fully clockwise the input connection to this potentiometer is broken by switch S204 and automatic reset will not occur. The DCU's hold the accumulated count until the RESET button is pressed. When this is done, the contacts of switch S205 are shorted, and a positive pulse is applied to the left-hand grid of the Reset Generator. This positive pulse triggers the Reset Generator, and causes it to produce a reset signal just as in automatic operation.

4.2 INPUT TRIGGER CHANNELS

(Refer to dwg. 7000 C 300.)

The input trigger channels are identical. Each channel produces an output pulse each time the attenuated input signal passes a selected voltage level. The output is independent of input waveform. The channel consists of a Schmitt trigger voltage discriminator preceded by a two-stage comparator amplifier. Each input channel is preceded by an attenuator, which divides the input voltage by 1, 10 or 100 according to the position of the ATTENUATION control. The input impedance at all positions is about 10 megohms in parallel with 40 $\mu\mu$f. When the ATTENuation control is at an AC position a .01 μf capacitor (C201) is inserted in series between the INPUT jack and the attenuator.

The comparator amplifier has two stages. The first is a difference amplifier whose output is proportional to the input voltage on the grid of V301A minus a selected constant voltage on the grid of V301B. The TRIGGER VOLTAGE potentiometer (R318) varies the voltage on the grid of V301B between -1 and +1 volts. The second stage (V302) amplifies the double-ended signal received from V301 and converts it to a single-ended low impedance output at the left-hand plate. This plate is connected to the input grid of the discriminator.

The voltage discriminator (V303) produces an output pulse each time the input voltage on its left-hand grid passes through a fixed voltage level (about +60 volts). Consider the input to this circuit as an a-c triggering signal superimposed on a d-c level. The a-c signal is an amplified reproduction of the voltage variations on the grid of V301A, that is, the attenuated input. The d-c level is determined by the voltage on the grid of V301B, a voltage set by the TRIGGER potentiometer. As the TRIGGER control is rotated toward "+", the d-c level is lowered and the discriminator triggers at a higher instantaneous voltage of the a-c signal and at a higher attenuated input voltage to the channel. When the TRIGGER control is turned toward "-", the channel triggers at a lower attenuated input voltage.

The discriminator (V303) is a two stage positive feedback amplifier. Feedback from the output stage occurs through the cathode coupling. The loop gain is slightly greater than one so that the circuit is regenerative and tends to assume one of two stable states. The output stage draws a steady current as long as the input grid remains below a certain triggering voltage. When the input exceeds this voltage the output tube is suddenly cut off. When the input voltage returns to a value slightly below the initial triggering voltage the output stage builds rapidly to its original steady current.

The difference between the level at which a positive-going voltage change triggers the circuit and the lower level at which a negative-going voltage change retriggers it is called the hysteresis of the circuit. At the input to the comparator amplifier the hysteresis is about 0.3 volts. The hysteresis determines the input sensitivity. An attenuated input signal weaker than 0.3 volts peak-to-peak or about 0.1 volts rms will not trigger a series of pulses. This means that any noise at the attenuated input below this level will not trigger extraneous pulses, although it may affect the time at which a pulse occurs.

The primary winding of T301, differentiates the rapid current changes in the output stage to produce a positive pulse at the plate when the circuit is triggered by a positive-going voltage and a negative pulse when triggered by a negative-going voltage. The secondary of T301 produces inverted pulses--a negative pulse when the circuit is triggered on a positive slope and a positive pulse when triggered on a negative slope.

4.3 OSCILLATOR AND SHAPER

(Refer to dwg. 7000 C 419)

The oscillator circuit consists of two sections: a crystal controlled oscillator stage (V401A), followed by a buffer amplifier (V401B). The oscillator stage uses an oven-controlled crystal, and is adjusted with the temperature stable capacitor, C410, which can shift the frequency of oscillation by a few cycles per second. Capacitor C404 has a nominal value as shown on the schematic diagram, but is selected at the factory to allow capacitor C410 to adjust the oscillator to the correct frequency.

The output of the oscillator stage drives the buffer amplifier, a pentode with a tuned circuit plate load. A portion of the output from the buffer amplifier is fed back to the oscillator stage to increase the amplitude stability of the signal.

The shaper stage (V402) amplifies and shapes the oscillator output for use as an input to the control circuitry and the dividers. The circuit is a voltage discriminator which operates in the same way as that discussed under "Input Trigger Channels". The trigger voltage level is set by adjusting R414. L402 differentiates the rapid current changes at the output plate to produce fast positive and negative pulses. The negative transients drive the first divider and the pulse output goes to the TIME switch (where it may be selected to

drive the Time Pulse Trigger). The output also goes directly to the FUNCTION switch where it provides pulses to be counted during the TEST operation and a start pulse for INPUT/N or TIG operation.

4.4 FREQUENCY DIVIDER CHAIN

(Refer to dwgs. 7151 C 3 and 7161 C 6.)

The divider chain is a series of cascaded monostable multivibrators. Each produces one output pulse for every ten input pulses. The Model 7351 has two dividers which scale its 100 KC oscillator frequency down to 1 KC. The Model 7361 has another divider preceding the last two which scales its 1 MC oscillator frequency down to 100 KC. Although the 1MC divider (V603) has additional circuitry to provide for high speed operation, it functions in essentially the same way. The process will therefore be described with reference to V743.

With no input the circuit is stable; the right-hand side is conducting because its grid is connected to +120 VDC and the left-hand side is cut off. A negative transient reaching the input capacitor (C745) is coupled through R752 and R753 to each of the two plates. The negative pulse produced on the left plate is coupled by C748 to the right grid. It appears as an amplified positive pulse at the right plate, which is coupled to the left grid throught C746. The left-hand side of the tube conducts, driving the left plate and the right grid even further negative. This regenerative action produces a quasi-stable state in which the right side is cut off and the left side is conducting. In this state the voltage on the right grid (called the "timing grid") is rising relatively slowly as the voltage at the wiper of potentiometer R760 charges the timing capacitor (C748) through R757. At the same time, negative input pulses at the right plate reach the left grid through C746 and appear as large positive pulses at the left plate. These pulses reach the timing grid through C748 and appear superimposed on the rising voltage curve there. When one of the positive pulses brings the timing grid above cutoff, the right side conducts and a reverse regenerative action returns the circuit to its original stable state. The slope of the rising grid voltage curve determines which of the successive positive pulses will rise above cutoff. The slope changes when the charging voltage at the wiper of R760 is raised or lowered. R760 is adjusted so that the ninth pulse rises above cutoff. The tenth pulse returns the circuit to the quasi-stable state.

In the interval between the ninth and tenth pulses the right side is conducting and the right plate is negative. The negative transient produced is the useful output of the divider. It goes to the TIME switch where it is available as a clock signal.

The additional circuitry associated with the 1 MC divider (V603) speeds up its response. V603 is a multivibrator which operates just as V743. V602A is a cathode follower inserted between the left plate of the multivibrator and the

timing grid. Its function is to discharge C606, the timing capacitor, within the brief 1 microsecond output pulse period so that the capacitor will pass the next positive pulse to the grid. V602B functions as a diode clamp on the left grid of the multivibrator. It prevents this grid from going so far negative during the 1 microsecond pulse output period that it will not rise above cutoff when the next positive pulse reaches it.

On the Model 7361, the TIME switch selects a negative output transient from one of the divider stages and feeds it to the Time Pulse Trigger (V601). The Time Pulse Trigger is a voltage discriminator which operates in the same way as that described in section 4.2, "Input Trigger Channels". Output clock pulses produced at L601 are coupled to the FUNCTION switch.

4.5 SELECTIVE DIGITAL DIVIDER

(Refer to dwg. 7151 D 2.)

The digital divider consists of the circuitry shown in block form in Figure 6. In the following discussion, the counter is assumed to be set up for E/UT X N operation.

In this mode of operation, the input signal whose frequency will be divided consists of clock pulses with the pulse interval indicated by the TIME-MILLISECONDS switch. Another input to the divider is a signal from the gate control binary (V203). This is the same signal which opens and closes the gate (V204) through which pulses pass to the indicating DCU's. The purpose of the digital divider during this operation is to extend the counting period by some multiple of the clock pulse interval. It will be assumed that the digital divider switches are set to "1000", which means that the counting period will be 1000 times the clock pulse interval. The process is then as follows:

(1) During the display period, clock pulses reach the Digital Divider Drive (V207). They are amplified and shaped, and then applied to the Divider Input Gate (V701) as well as the Coincidence Gate (V702B). At this time, however, both these gates are held closed by the signal from the Control Binary (V203).

(2) A reset pulse resets the indicating DCU's to a registered count of zero and, at the same time resets the digital divider to a registered count of one (0001).

(3) A clock pulse (which will be called "clock pulse No. 1") actuates the gate control circuitry, thus flipping the Control Binary. The Control Binary opens gate V204, allowing the indicating DCU's to begin counting. Clock pulse No. 1, however, does not pass through either gate in the digital divider, because the signal from the Control Binary is delayed long enough to hold both these gates closed until the pulse has subsided.

(4) Clock pulse No. 2 passes through the Divider Input Gate (which is now open) causing the digital divider to tally one count. The divider now has a registered count of 0002. However, this pulse does not pass through the Coincidence Gate because this gate will remain closed until the registered count on the divider DCU's coincides with the number to which the switches are set (which in this case is "1000").

(5) The digital divider continues to be driven by clock pulses Nos. 3 thru 1000. After pulse No. 1000, the divider has a registered count of 1000, and the coincidence gate is open.

(6) Clock pulse No. 1001 passes through the coincidence gate and triggers the Blocking Oscillator, V702A. The Blocking Oscillator generates a "stop" pulse which, applied to the gate control circuitry, closes the gate admitting pulses to the indicating DCU's and thus stops the counting action. Notice that the elapsed time between clock pulse No. 1, which initiated the counting period, and clock pulse No. 1001, which ended the counting period, is equal to 1000 pulse intervals.

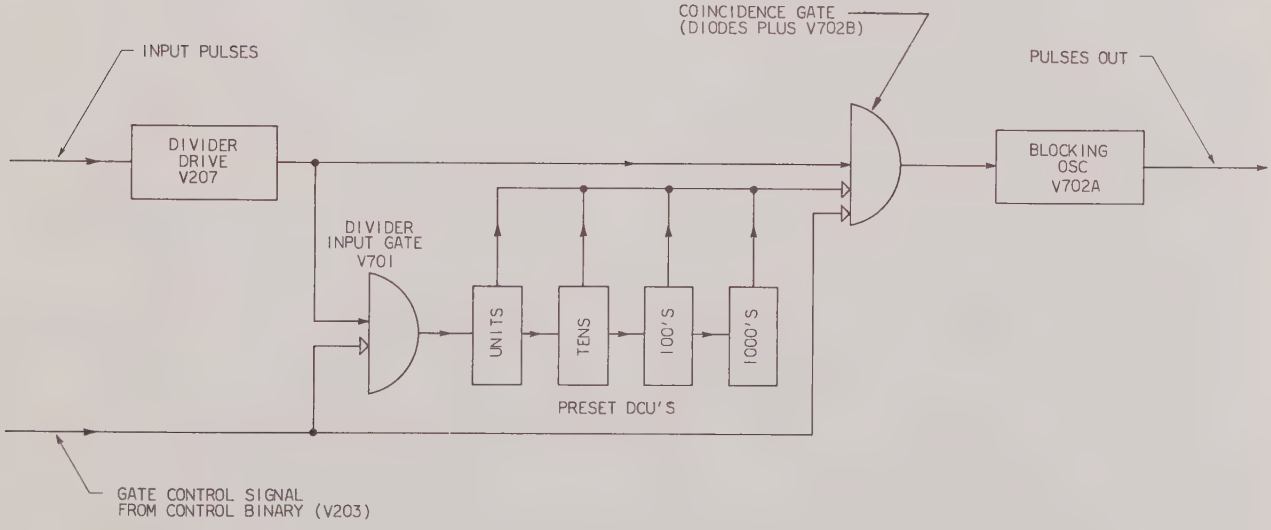


FIG. 6 BLOCK DIAGRAM OF THE SELECTIVE DIGITAL DIVIDER

The preset switch (S701) applies +210 VDC through a one megohm resistor to all coincidence diodes except those in the readout lines which will be positive of ground when the DCU is registering the preset digit. When the DCU is not registering the preset digit, at least one diode will be in a readout line which is negative of ground. Current drawn through this diode and through resistor R705 lowers the voltage at the coincidence bus to approximately -15 VDC. This voltage, applied to the grid of V702B, holds this grid well below cutoff so that pulses from C704 cannot cause the tube to conduct. When all DCU's are registering the digit preset on each, all the coincidence diodes are connected either to a readout line which is positive of ground or to the +210 VDC supply. Under these conditions the coincidence bus goes positive up to ground level, where it is clamped by CR702. With the grid of V702B biased at ground potential, a positive pulse from C704 rises above cutoff, causing V702B to conduct and triggering Blocking Oscillator V702A.

The Blocking Oscillator generates a 12 microsecond, -200 volt pulse at its plate. This signal supplies a -100 volt pulse for resetting the DCU's in the digital divider, and a 2 volt negative pulse across a 100 ohm resistor at the TIME jack. The same signal is also coupled to a pulse transformer (T280) which generates 0.5 microsecond positive and negative pulses for use elsewhere. The negative pulses are used to trigger the Control Binary and the positive pulses are counted by the indicating DCU's when the unit is used as a totalizer.

The Blocking Oscillator resets the DCU's in the digital divider but does not reset the indicating DCU's. However, the RESET button will reset the DCU's in the divider as well as the indicating DCU's. This enables the operator to stop the divider DCU's manually at any time.

4.6 POWER SUPPLY

Two bridge rectifiers supply +210 volts unregulated and -110 volts unregulated. From these voltages are derived +120 volts regulated, -60 volts regulated, and -35 volts unregulated.

A Zener diode (CR106) stabilizes the -60 volt supply. This in turn acts as a reference voltage for the +120 volt regulator circuit, which consists of an amplifier (V101) and a series regulator tube (V102). A voltage divider (R106, R107, R113, R116) is connected between the regulated +120 volt supply and the -60 volt reference. The control grid of V101 is connected to a point on this divider that is adjusted by R113 (the +120 V ADJUST control) to be slightly below ground when the regulated output is +120 volts. Since the plate of V101 is coupled through R105 and R110 to the control grids of V102, any increase in the regulated output voltage appears as a decrease in the grid bias applied to V102. The plate resistance of V102 increases, and with it the voltage drop across the tube; so the output voltage drops back to +120 volts. Similarly, if the output voltage goes down, the plate resistance of V102 decreases, thus restoring the output to +120 volts.

TYPICAL WAVEFORMS

Models 7351 & 8351, 7361 & 8361

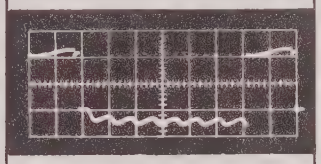
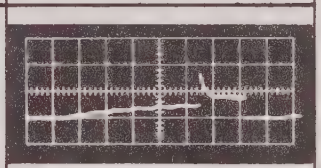
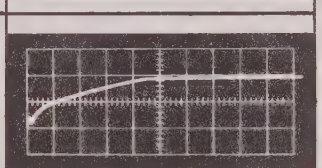
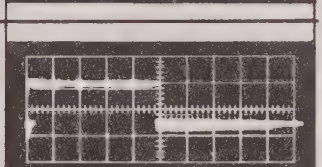
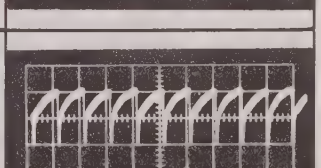
Photographed on a Tektronix Model 543A Oscilloscope with a type CA Preamplifier.

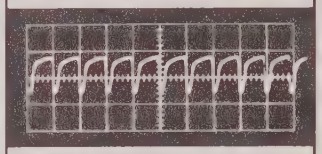
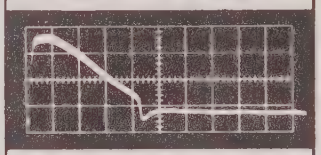
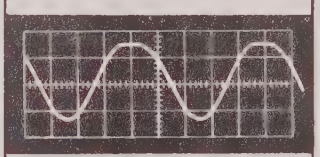
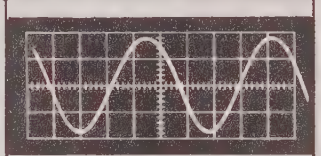
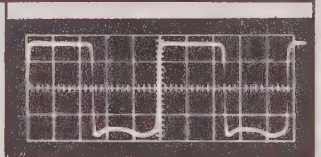
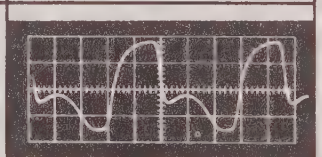
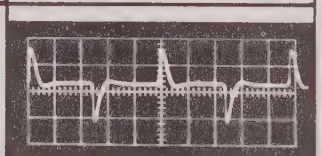
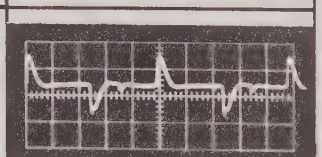
NOTES:

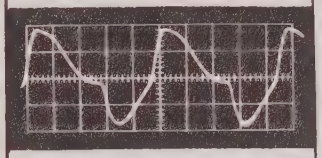
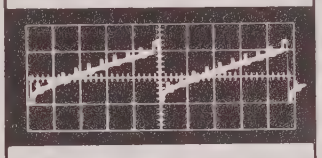
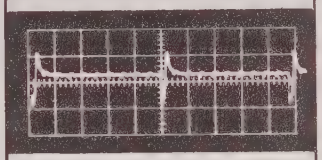
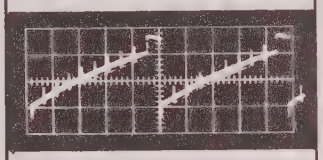
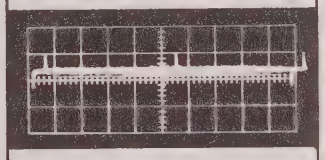
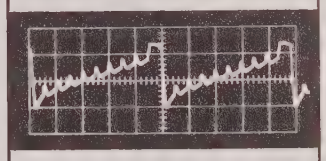
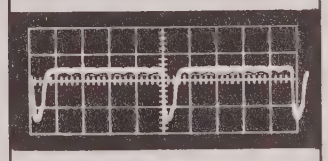
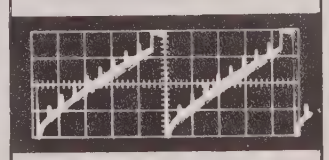
1) Test Point. Circled numerals on the schematic diagrams show the test points, some of which appear on more than one diagram.

2) Signal. Unless specially noted, waveforms are similar in each model. Model 7351 waveforms apply also to the Model 8351. Model 7361 waveforms apply also to the Model 8361.

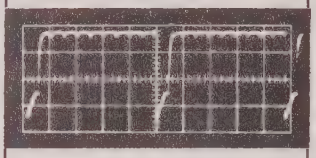
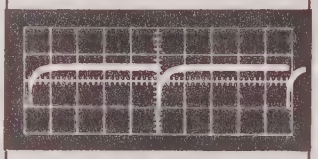
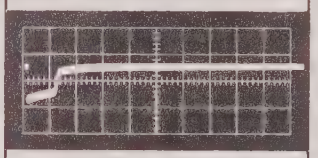
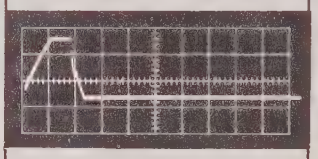
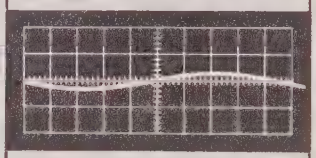
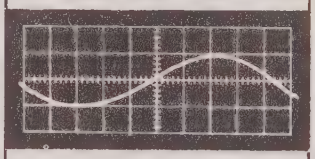
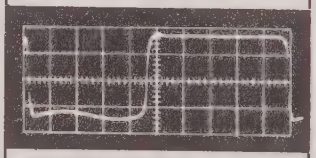
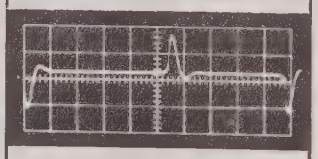
3) Test Conditions. Except where no conditions are stated:
   1) Place the FUNCTION Selector at TEST.
   2) Turn the DISPLAY control fully counter-clockwise for minimum display time.
   3) Place the TIME Selector at the MILLISECONDS position shown.

Test Point	Signal	Scale per Div. Vert.	Scale per Div. Horiz.	Test Conditions	Typical Waveform
(1) Jct. R236 & R239	Reset control	10v	10ms	TEST, 1.0 MILLISEC. Min. DISPLAY time. Scope dc coupled. Ground is line above center.	
(2) V206, pin 7	Display timing	50v	10 ms	Same as No. 1 except that ground is line below center.	
(3) Jct. C214 & CR209	Reset signal	50v	200μs	TEST, 1.0 MILLISEC. Min. DISPLAY time. Scope dc coupled. -110v is line above center. Rise time approx. 5μs.	
(4) V204, pin 7	Gate open/close	10v	200μs	Same as No. 1	
(5) V204, pin 5	a) DCU drive pulses (7351)	5v	10μs	TEST, 1.0 MILLISEC. Min. DISPLAY time.	

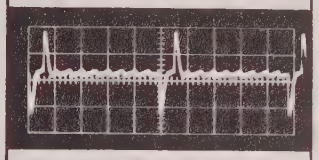
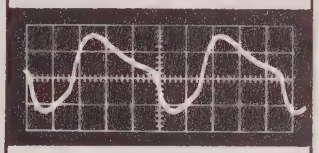
Test Point	Signal	Scale per Div. Vert.	Horiz.	Test Conditions	Typical Waveform
(5) V204, pin 5	b) DCU drive pulses (7361)	5v	1μs	TEST, 1.0 MILLISEC. Min. DISPLAY time.	
(6) V207, pin 3	Digital Divider drive pulses	10v	0.5μs	Same as No. 5	
(7) V401, pin 6	a) 100 kc Oscillator output (7351)	5v	2μs		
(7) V401, pin 6	b) 1 mc Oscillator output (7361)	5v	0.2μs		
(8) V402, pin 6	a) Shaper, pin 6 (7351)	5v	2μs	Same as No. 5	
(8) V402, pin 6	b) Shaper, pin 6 (7361)	5v	0.2μs	Same as No. 5	
(9) V402, pin 1	a) Shaper output (7351)	5v	2μs	Same as No. 5	
(9) V402, pin 1	b) Shaper output output (7351)	5v	2μs	TEST, .01 MILLISEC.	

Test Point	Signal	Scale per Div. Vert.	Horiz.	Test Conditions	Typical Waveform
(9) V402, pin 1	c) Shaper output (7361)	5v	0.2μs	Same as No. 5	
(10) V742, pin 2	100 kc Divider timing grid (7351)	20v	20μs	Same as No. 5	
(11) Jct. T741 & R744	100 kc Divider output (7351)	10v	20μs	Same as No. 5	
(12) V743, pin 7	10 kc Divider timing grid (7351)	20v	20μs	Same as No. 5	
(13) Jct. T742 & R751	10 kc Divider output (7351)	10v	20μs	Same as No. 5	
(14) V603, pin 2	1 mc Divider timing grid (7361)	10v	2μs	Same as No. 5	
(15) Jct. R615 & R616	1 mc Divider output (7361)	10v	2μs	Same as No. 5	
(16) V742, pin 2	100 kc Divider * timing grid (7361)	10v	2μs	Same as No. 5	

*Except for time scale (20μs/div.), 10 kc Divider timing grid waveform (V743, pin 7) is similar to (16)

Test Point	Signal	Scale per Div. Vert.	Scale per Div. Horiz.	Test Conditions	Typical Waveform
(17) Jct. R742 & R744	100 kc Divider * output (7361)	10v	2μs	Same as No. 5	
(18) V701, pin 5	Digital Divider DCU input	100v	20μs	TEST, 0.1 MILLISEC. N = 0010 Min. DISPLAY time.	
(19) Jct. T701 & R714	Digital Divider output	100v	5μs	Same as No. 18	
(20) A701, pin 3	Digital Divider coincidence line	10v	50μs	Same as No. 18	
(21) V301, pin 7	Comparator Amplifier input	0.5v	1μs	100 kc, 100 mv rms input signal	
(22) V302, pin 1	Comparator Amplifier output	5v	1μs	100 kc, 100 mv rms input signal	
(23) V303, pin 6	Voltage Discriminator pin 6	5v	1μs	100 kc, 100 mv rms input signal	
(24) V303, pin 1	Input Channel output	5v	1μs	100 kc, 100 mv rms input signal	

*Except for time scale (20μs/div.), 10 kc Divider output waveform (Jct. R749 & R751) is similar to (17)

Test Point	Signal	Scale per Div. Vert.	Scale per Div. Horiz.	Test Conditions	Typical Waveform
(25) V601, pin 1	a) Time Pulse Trigger output (7361)	5v	2μs	TEST, .01 MILLISEC.	
(25) V601, pin 1	b) Time Pulse Trigger output (7361)	5v	0.2μs	TEST, .001 MILLISEC.	

NOTE

Modified instruments are identified by one or more letters after the model number, each letter standing for one of the modifications described. For example, the Model 7150DR is a standard 7150 that has been modified to incorporate an oven-controlled crystal instead of an unheated crystal (Modification D) and is fitted for rack mounting (Modification R).

Some modifications in this section may not appear in alphabetical order.

Not all the modifications described are applicable to every instrument. For information on suitable modifications, get in touch with the factory or with any of the Beckman representatives listed at the back of the manual.

MODIFICATION B

Modification B extends the count capacity by a factor of 10 or divides the frequency of the start and stop pulses by 10.

Models 7151, 7351, 8151, and 8351

A Model 775Z (Model 777Z for 8151 and 8351), A705, is placed between the Divider Input Gate, V701, and DCU A704. When switch S206 is in the "N X 10" position, A705 divides the digital divider drive pulses by 10, raising the maximum input frequency from 10 kc to 100 kc. In the "N X 1" position, the instrument works as if unmodified. The circuit changes are shown in Figure B.

Other Models

The schematic diagrams of the other instruments for which modification B is available show the modified circuitry.

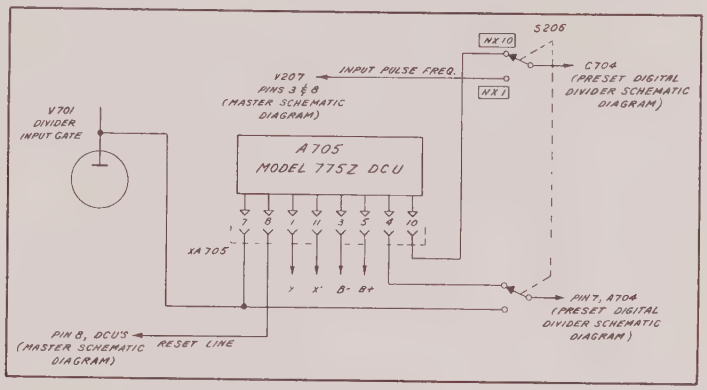


FIG. B. Circuit changes for modification B in Models 7151, 7351, 8151, and 8351.

MODIFICATION C

An instrument with modification C has a mechanical register that extends the count capacity by three extra digits. The register coil is the plate load of a one-shot multivibrator, V21 driven by the output signal of DCU A202; thus, the register records one count for every output pulse of the DCU.

The register is reset manually by a small lever on the front panel just below the register dials and is not affected by the electronic signal that resets the DCU's.

In C-modified instruments with "X 10" modes of operation, the count-indicating panel of the DCU Divider, A201, is not exposed to view, and the digit normally displayed by A201 appears as the right-hand digit of the register.

When A202 resets, it may give an output pulse. To stop this from registering, the reset line is connected to the control grid, pin 2, of V21 so that the inverted reset pulse appearing at the plate, pin 1, suppresses the false count.

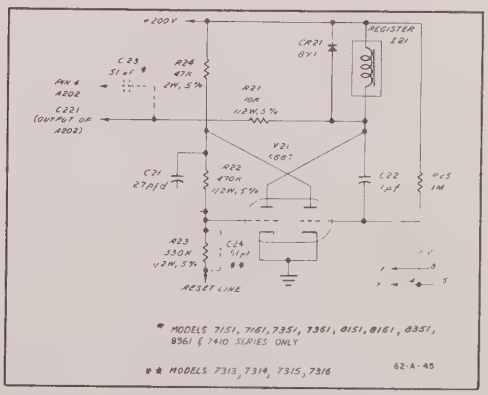


FIG. C. Circuit of modification C.

MODIFICATION D

The frequency stability of the clock pulse generator in instruments using an unheated crystal is 1 part in 10^5 per day. Modification D substitutes a temperature-controlled crystal for the unheated type and improves the oscillator stability to 1 part in 10^6 per day.

Power for the heating element in the crystal oven is taken from one of the filament circuits in the instrument (the circuit that has one side grounded). The circuitry is shown on the crystal oscillator schematic diagrams of the instruments concerned.

MODIFICATION H

Instruments with this modification have a power transformer with a 222-volt primary instead of the standard 117-volt, the primary being two windings in series, a 117-volt and a 105-volt. The line fuses, F101 and F102, have one-half the current rating of those in the standard instruments. Figure H-1 shows the modified circuitry. Note that in instruments with a 1 Mc heated crystal in the oscillator, the crystal oven no longer begins heating as soon as the line cord is plugged into a power receptacle, but heats only when the POWER switch is on.

If operation on 210 volts or 231 volts is desired, take the wire off terminal 2 of the transformer and connect this wire to terminal 14 or 11 respectively.

To convert to 117-volt operation, rewire the transformer connections as shown in Figure H-2 and replace F101 and F102 with fuses of twice the current rating.

If an instrument with the H modification also has an N modification, refer to the N modification section for further details on power transformer and wiring changes.

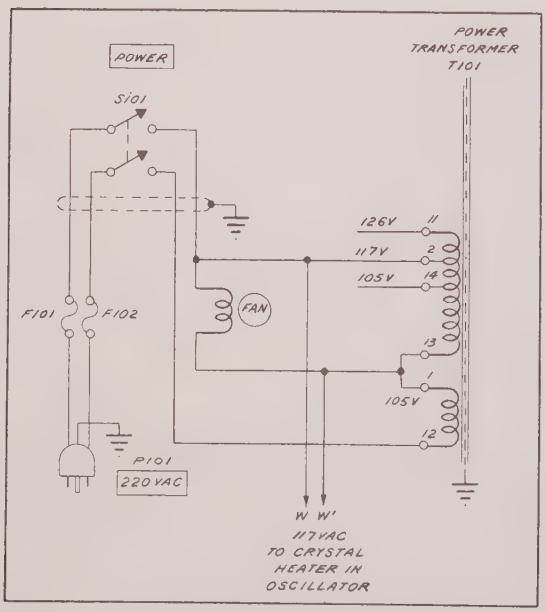


FIG. H-1. Circuit changes in power supply for modification H.

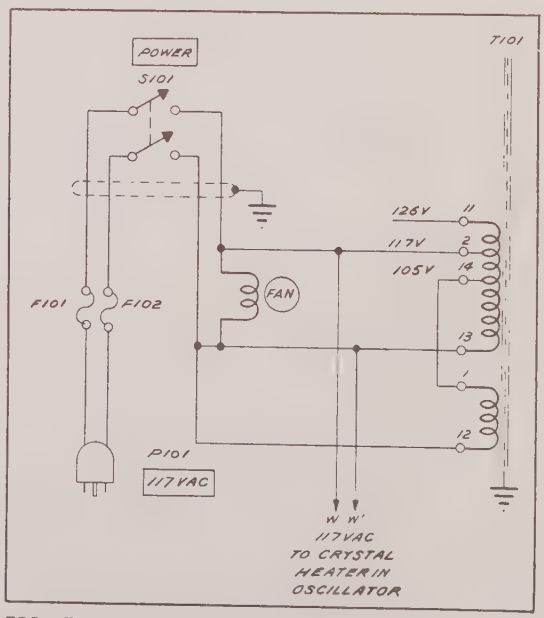


FIG. H-2. Rewiring modification H to operate on 117 volts ac.

MODIFICATION K

To increase the input sensitivity of a counter from 100 mv rms to 5 mv rms, a step-up transformer is inserted between the attenuator and the first grid of any input channel used in count modes. The transformer is put in or out of circuit by a front panel switch (S350) marked HIGH (transformer in) and NORM (transformer out and attenuator connected straight through to the first grid). It should be switched in only if the input signal is below the sensitivity of the counter.

With the transformer connected, the ATTENUATION control should be at DC-1. Under these conditions the input impedance will vary with frequency, rising from at least 300 ohms at 5 cps to about 25K ohms at 10 kc. Sensitivity is at least 5 mv over this range.

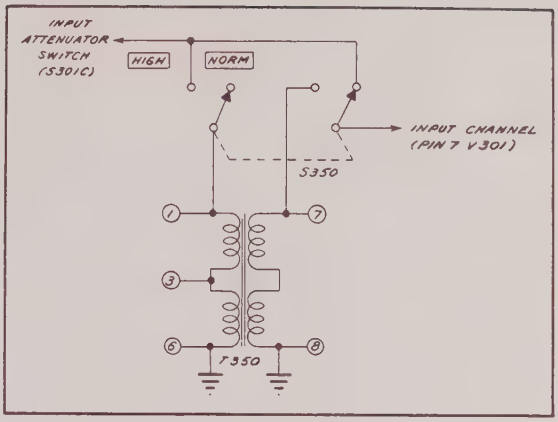


FIG. K. Circuit diagram for modification K.

MODIFICATION L

Applicable to Preset EPUT® Meters or Preset Universal EPUT® and Timers, this modification permits remote control of the digital divider setting, as well as normal control from the front panel.

The sockets of the digital divider DCU's are wired to a female connector (J801) on the rear chassis lip. One matching plug, on a flexible lead coming out of the rear lip, is wired to the internal preset switches; another is provided for wiring to remote preset switches. Front panel control or remote control is obtained by inserting the appropriate plug into J801.

Figure L shows the internal connections to J801 and gives the recommended wiring of a manually-operated external preset switch. In this application the voltages at pins 21, 22, and 23 of J801 are not used.

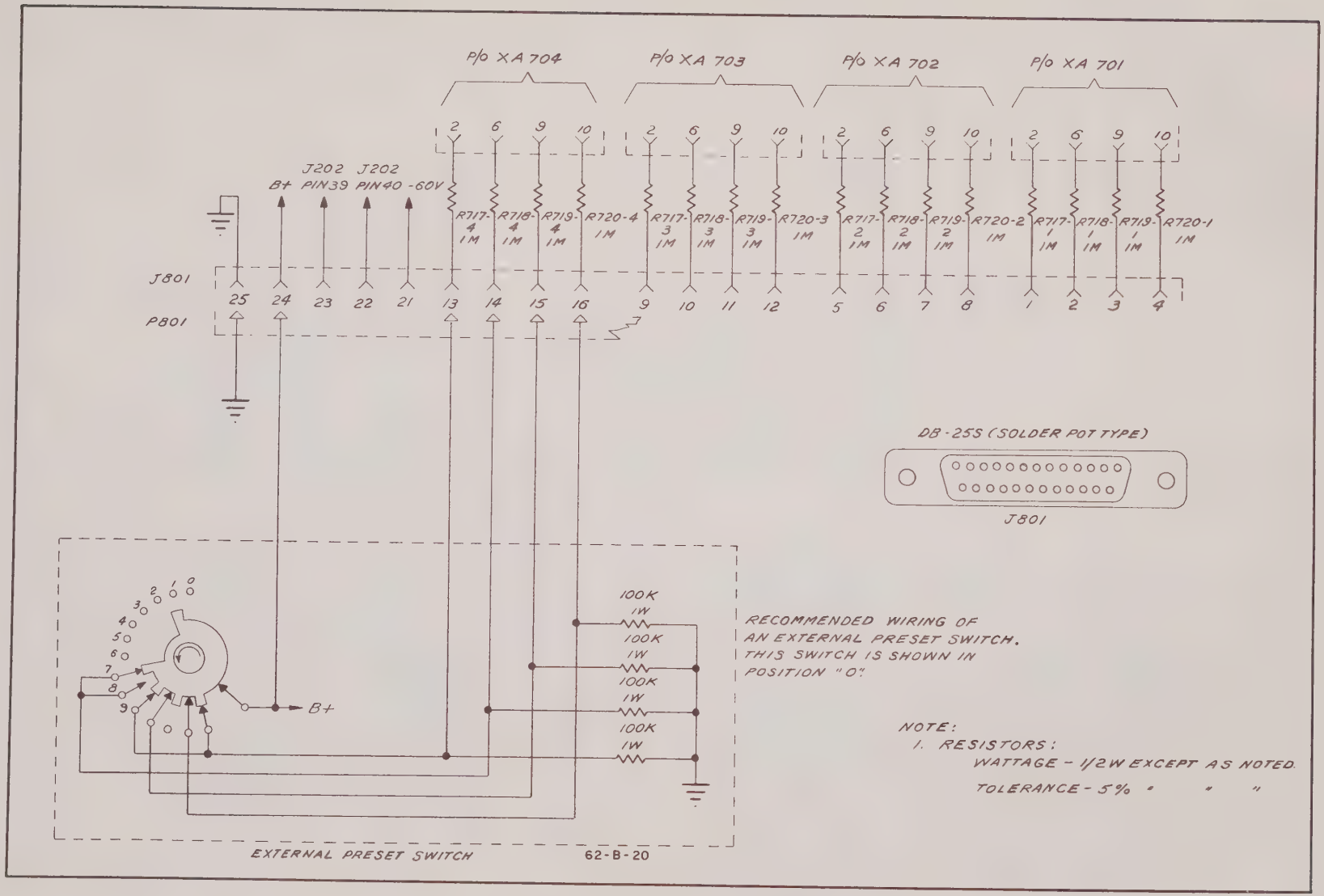


FIG. L. Wiring diagram for modification L.

MODIFICATION N

1. GENERAL DESCRIPTION

The N modification, shown in block diagram form in Figure N-1, provides an oscillator stability of 5 parts in 10^8 per week in contrast to the 3 parts in 10^7 per week of the unmodified instruments.

In place of the 1 Mc crystal oven unit that plugs into the oscillator section, instruments with this modification have a double oven mounted on the oscillator chassis. The outer oven is heated by a 117 volt element, thermostatically controlled to stay within 2° C of a nominal 70° C. Inside this oven is a second oven whose temperature is kept within approximately 0.005° C of a nominal 75° C by proportional control. The inner oven contains a temperature-stable crystal that provides the 1 Mc standard for the time base generator in the instrument. As shown in Figure N-3, the circuit of the crystal oscillator (V401) is changed and an amplifier stage (V402) is inserted between the oscillator and the shaper.

In addition, the shaper (now V601 instead of V402) is moved to the frequency divider chassis.

The heating element for the inner oven is a resistance bridge energized by the output of an amplifier (V450 and V451) located on the power supply chassis (see Figure N-3). Two opposite arms of the bridge are made of wire whose resistance changes in proportion to temperature; the other two arms are relatively insensitive to temperature changes. Amplifier and bridge form a closed-loop oscillatory circuit, the error signal from the unbalanced bridge being fed back to the amplifier input in proportion to the temperature difference between the actual and the design temperature of the oven. Since there is a continuous loss of heat from the inner to the outer oven, temperature control of the inner oven is uninterrupted. Thus, the temperature variations normally resulting from the cyclic character of thermostatic control are avoided.

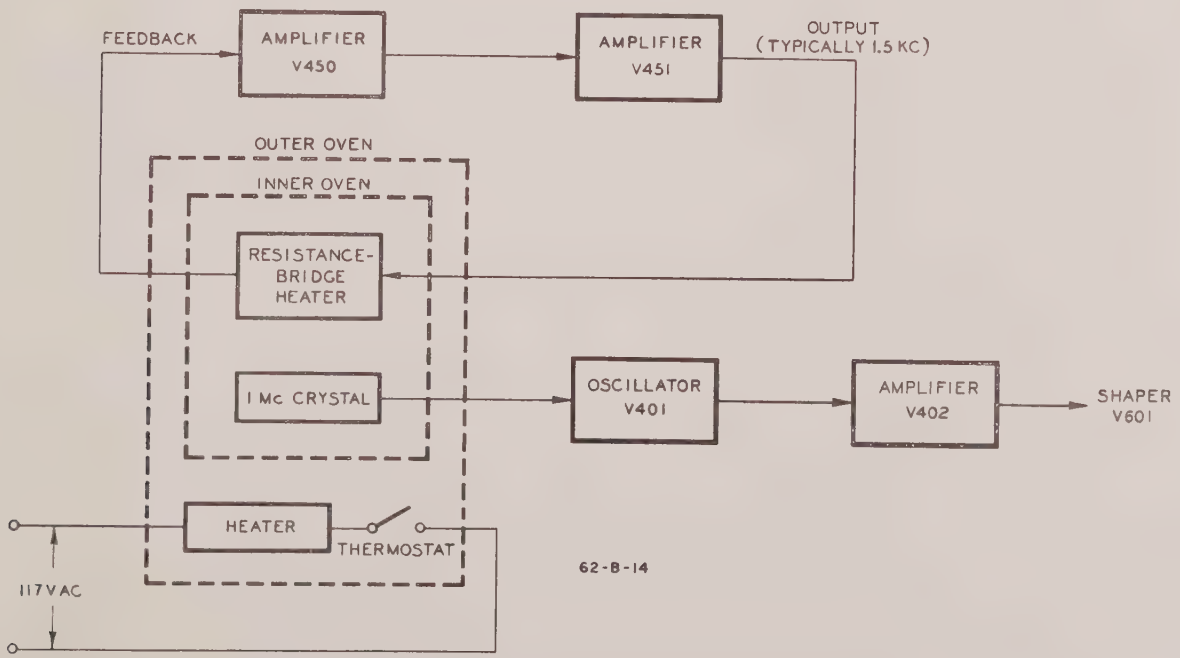


FIG. N-1. Block diagram of modification N.

1.2 OSCILLATOR ADJUSTMENTS

Oscillator adjustments are seldom required for N modifications, except when tubes or components are replaced. An adjustment procedure is given in this N modification section.

There are two adjustments in the N modification: frequency and amplitude. Frequency adjustments are made by varying C405; amplitude adjustments by tuning L401. Adjust L401 first since it has a slight effect on the oscillator frequency.

If the oscillator does not work properly, check supply voltages, tubes and components with the aid of schematic diagram, Figure N-3. When the oscillator is working, but slightly out of adjustment – either from normal use or servicing – use this procedure:

a) Adjustment of L401

1) Remove the bottom cover from the N modification assembly as shown in Figure N-2 and locate the L401 adjustment.

2) Use a VTVM to measure from the junction of R410 and R411 (see Figure N-2) to ground. Use minus polarity.

3) Tune L401 for maximum voltage. The voltage range should vary from -4 to -12 volts depending on the resonant impedance of the crystal, and characteristics of tube V401.

> NOTE
>
> Since tuning is broad, the center of adjustment can be found by rotating the tuning slug midway between the positions that cause a noticeable decrease in voltage. Inductor L401 should not be used as a frequency setting adjustment.

b) Adjustment of C405

The oscillator frequency is set at the factory. The stability is 5 parts in 10^8 per week, therefore, do not adjust unless a frequency standard at least that accurate is available. If a precise 1 Mc standard is available, follow these steps:

1) Use Figure N-2 as a guide to locate trimmer adjustment C405.

2) Connect the output from FREQ Jack J401 to the vertical input of an oscilloscope. Then, couple a 1 Mc standard to the horizontal input and adjust C405 for a Lissajous pattern indicating equal frequency.

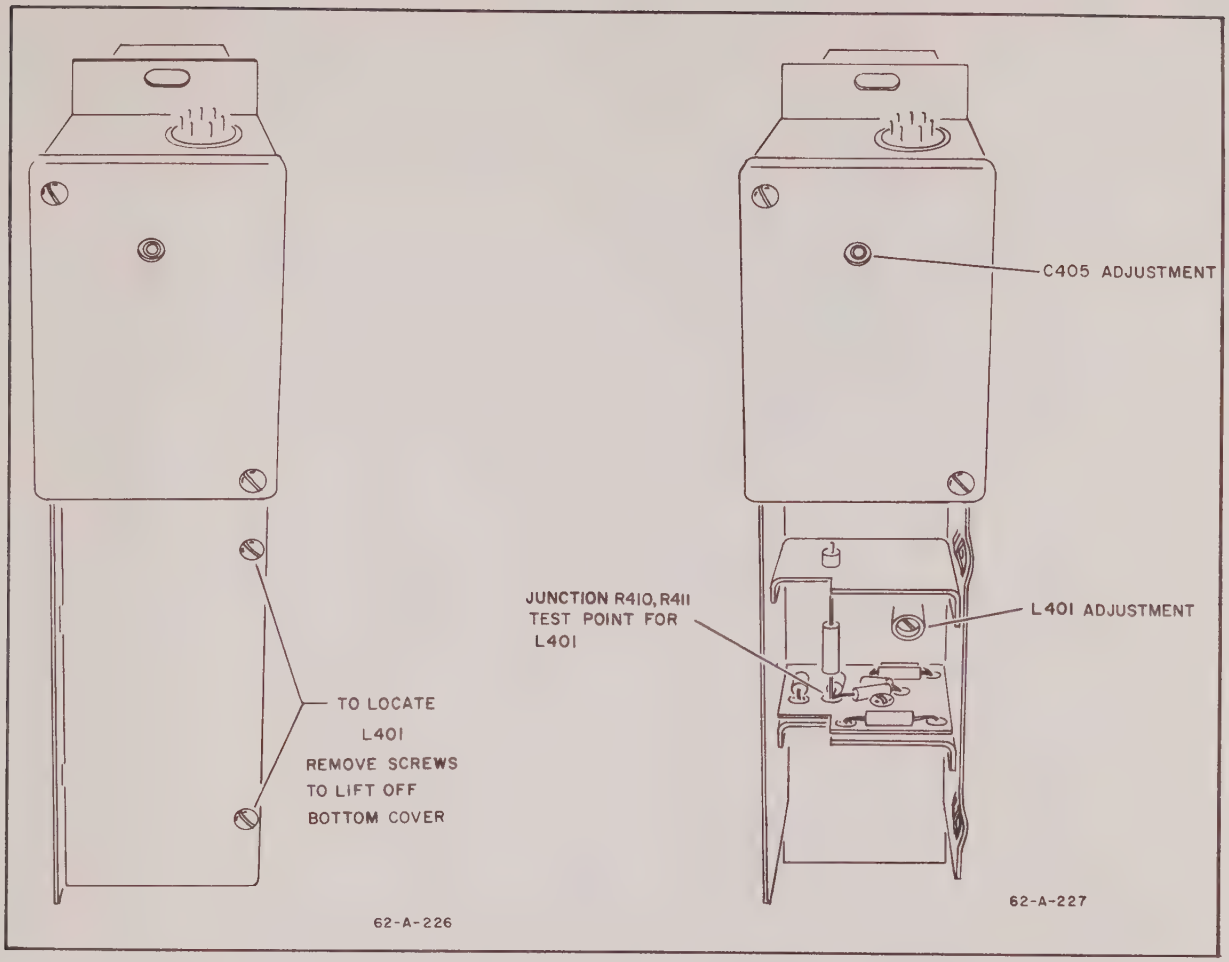


FIG. N-2. Illustrates location of N modification adjustments. Underchassis view.

Instruments having both the H and N modifications require a different power transformer for the N modification. A power transformer is used with a 222-volt primary instead of the standard 117-volt, the primary being two windings in series, a 117-volt and a 105-volt. The line fuses, F450 and F451, have one-half the current rating of those in the standard N modification. If operation on 210 volts or 231 volts is desired, take the wire off terminal 3 of the transformer and connect this wire to terminal 2 or 4 respectively. Figure HN-1 shows the modified circuitry.

To convert to 117-volt operation, rewire the transformer connections as shown in Figure HN-2 and replace F450 and F451 with fuses of twice the current rating. The correct current rating is listed on the power supply schematic diagrams of the instruments.

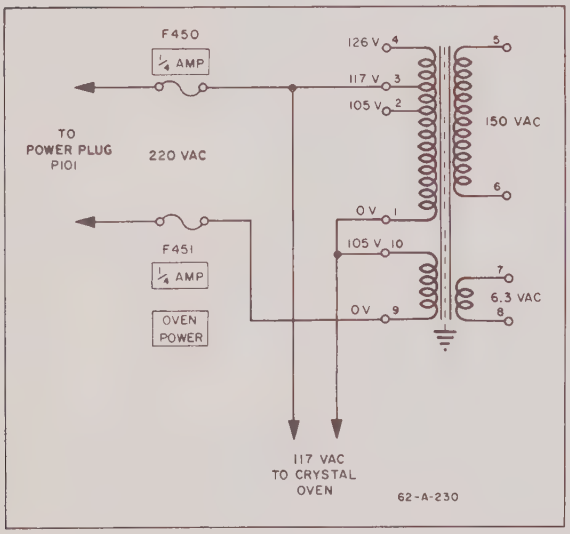


FIG. HN-1. Circuit changes in power supply for 220 volt operation.

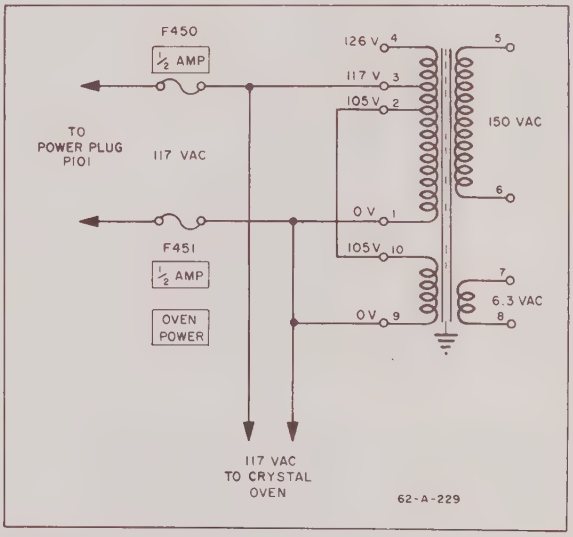
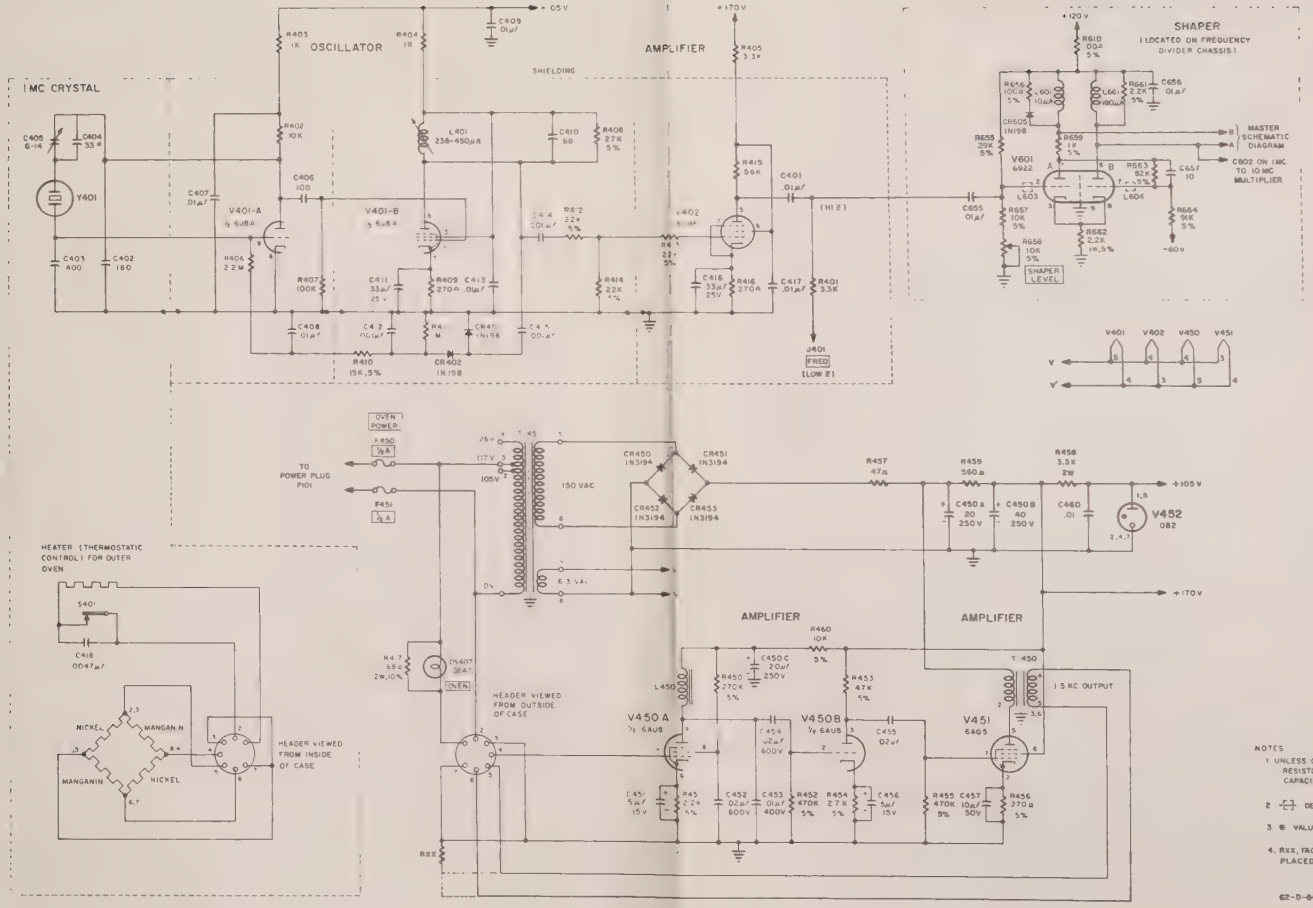


FIG. HN-2. Rewiring power supply for 117 volt operation.



NOTES

1. UNLESS OTHERWISE NOTED RESISTORS ARE IN OHMS, ½ W, 10% CAPACITORS ARE IN PICOFARADS
2. DENOTES FERRITE BEAD
3. * VALUE FACTORY SELECTED
4. RXX, FACTORY SELECTED AND PLACED

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REV 1

FIG. N-3. Oscillator and amplifier in modification N.

MODIFICATION R

Instruments with this modification are intended for mounting in a standard relay rack and are supplied without a cabinet but with a top dust cover. Mounting dimensions are given in Figure R.

The air intake ports in the sides of the chassis and the exhaust opening at the back should be kept free from obstruction so that the forced-draft cooling system can work efficiently. For the same reason, the dust cover must be kept in place when the instrument is in operation, as overheating can cause serious damage to components.

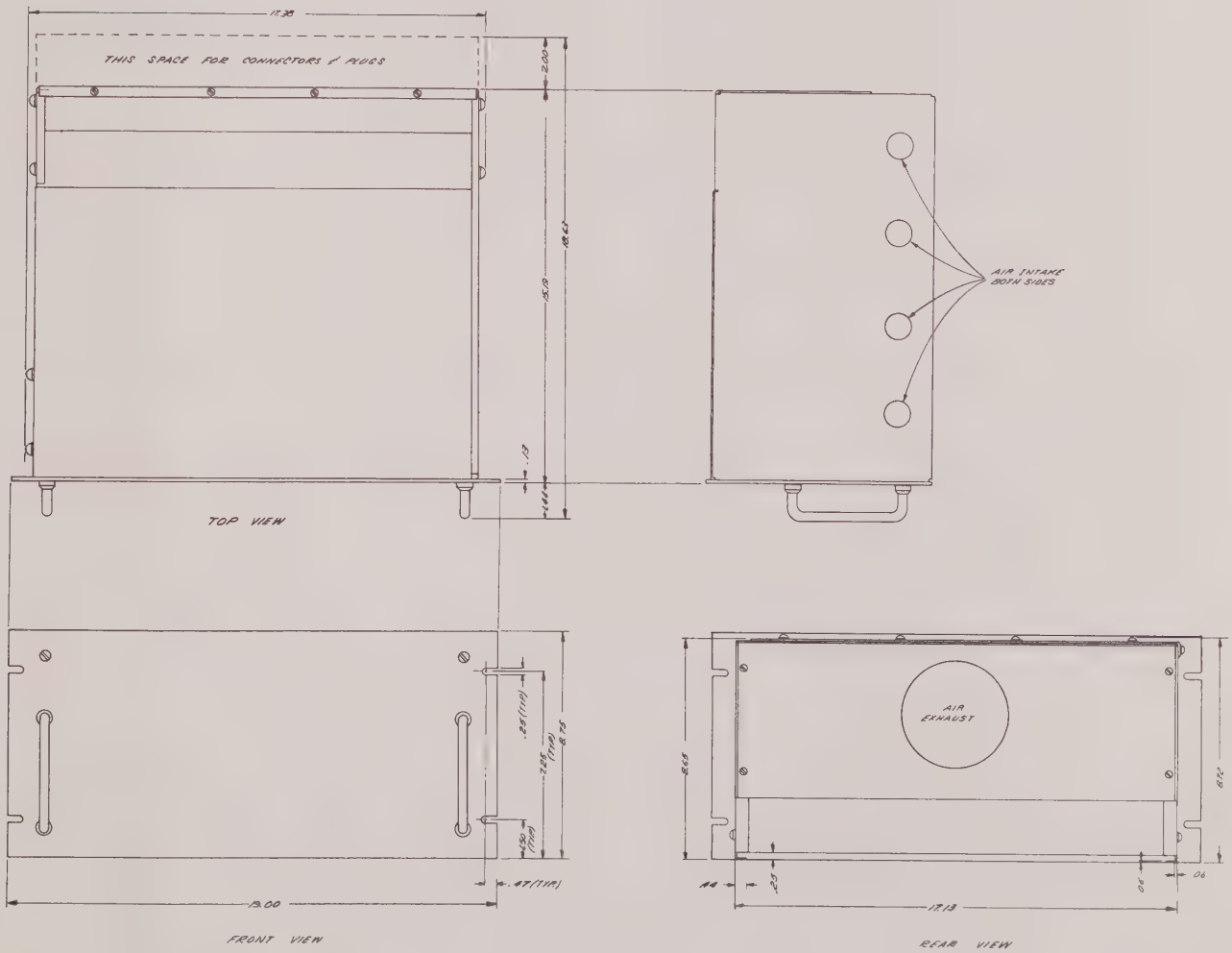


FIG. R. Rack mounting dimensions for 7000 and 8000 model series instruments.

MODIFICATION T

In contrast to the standard Beckman/Berkeley 1-2-2-4 readout code, instruments with the T modification furnish a 1-2-4-8 readout. The modified code is supplied by special DCU's substituted for the standard units. These DCU's are designated by the letter "R" following the model number.

The only modification to the wiring of the instrument is that pin 35 of the DIGITAL RECORDER connector, J202, is grounded.

MODIFICATION U

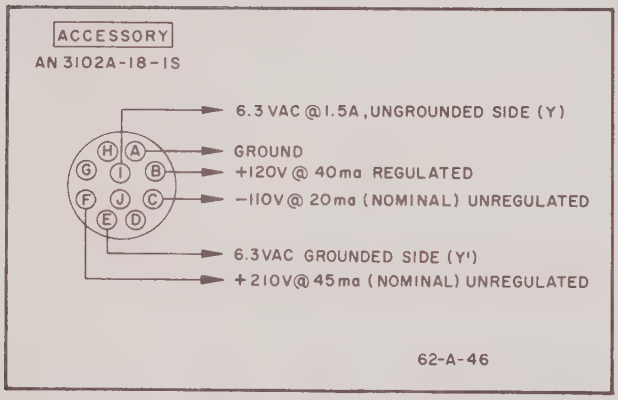


FIG. U. Connections to accessory socket in modification U.

Modification U supplies power for auxiliary equipment through an ACCESSORY socket on the rear chassis lip of the instrument.

MODIFICATION W

This modification adds a circuit that provides strobe pulses of variable width for external use (see Figure W).

The circuit consists of two identical one-shots (V901 and V902) driven by the "start" and "stop" pulses coming from the FUNCTION switch. One-shot V901 is triggered by "start" pulses, and V902 by "stop" pulses. When one of these negative pulses appears at the input grid (pin 7), the one-shot flips to the quasi-stable state and then back to its stable state. In so doing, it generates a negative output pulse of about 25 volts at one of the plates (pin 1). The duration of the quasi-stable state, and hence the width of the output pulse, depends on the capacitance put into the circuit by the STROBE PULSE WIDTH switch (S901).

The negative output pulses from the one-shots appear at the STROBES jacks (START, J901, and STOP, J902) on the rear panel of the instrument. Capacitors C201 and C206 are replaced by C919 and C920 respectively. The pulses can be applied to the Z axis of an oscilloscope to intensify the input waveform at the points where the input channel of a counter is being triggered.

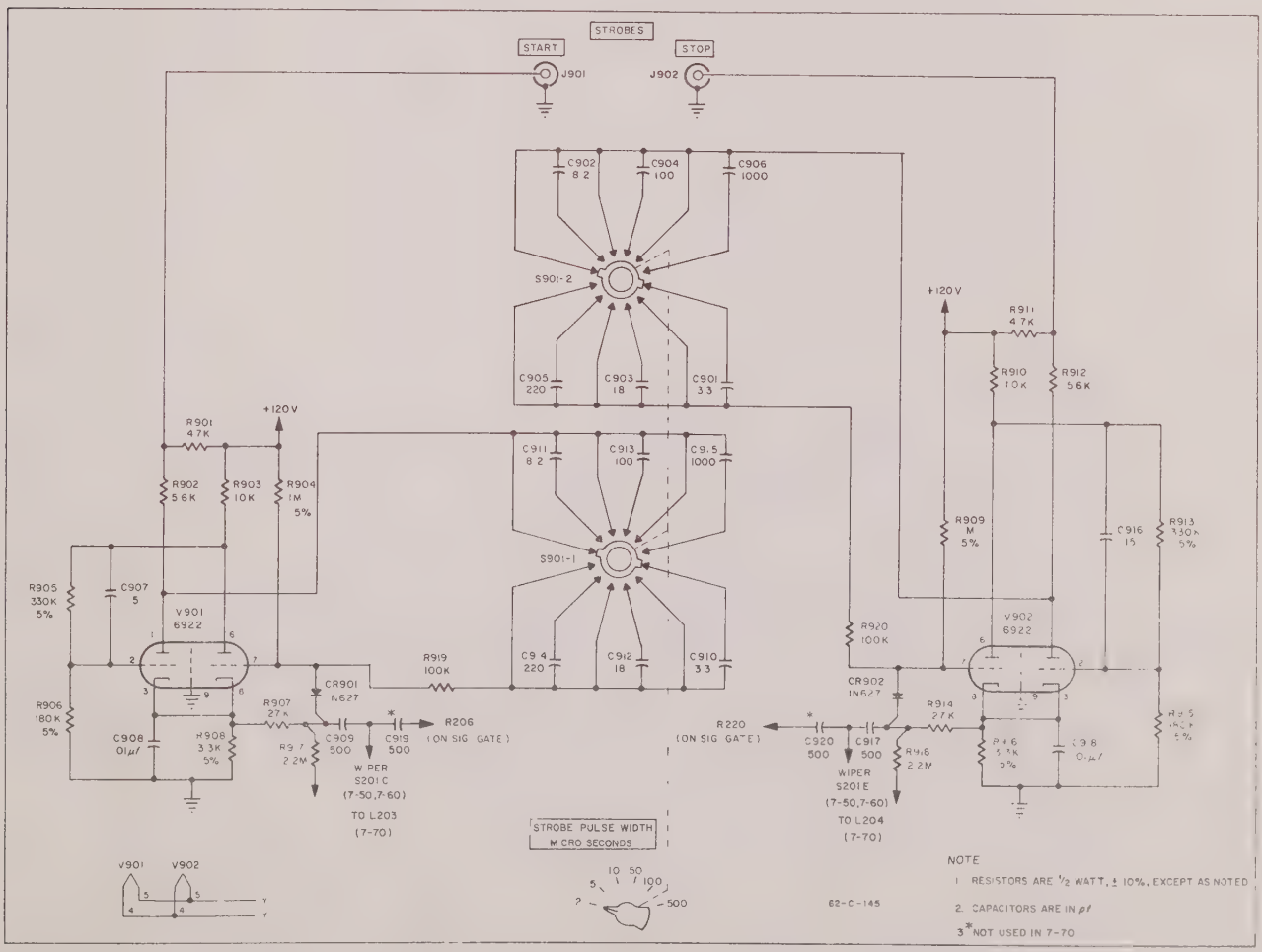


FIG. W. Circuit diagram for modification W.

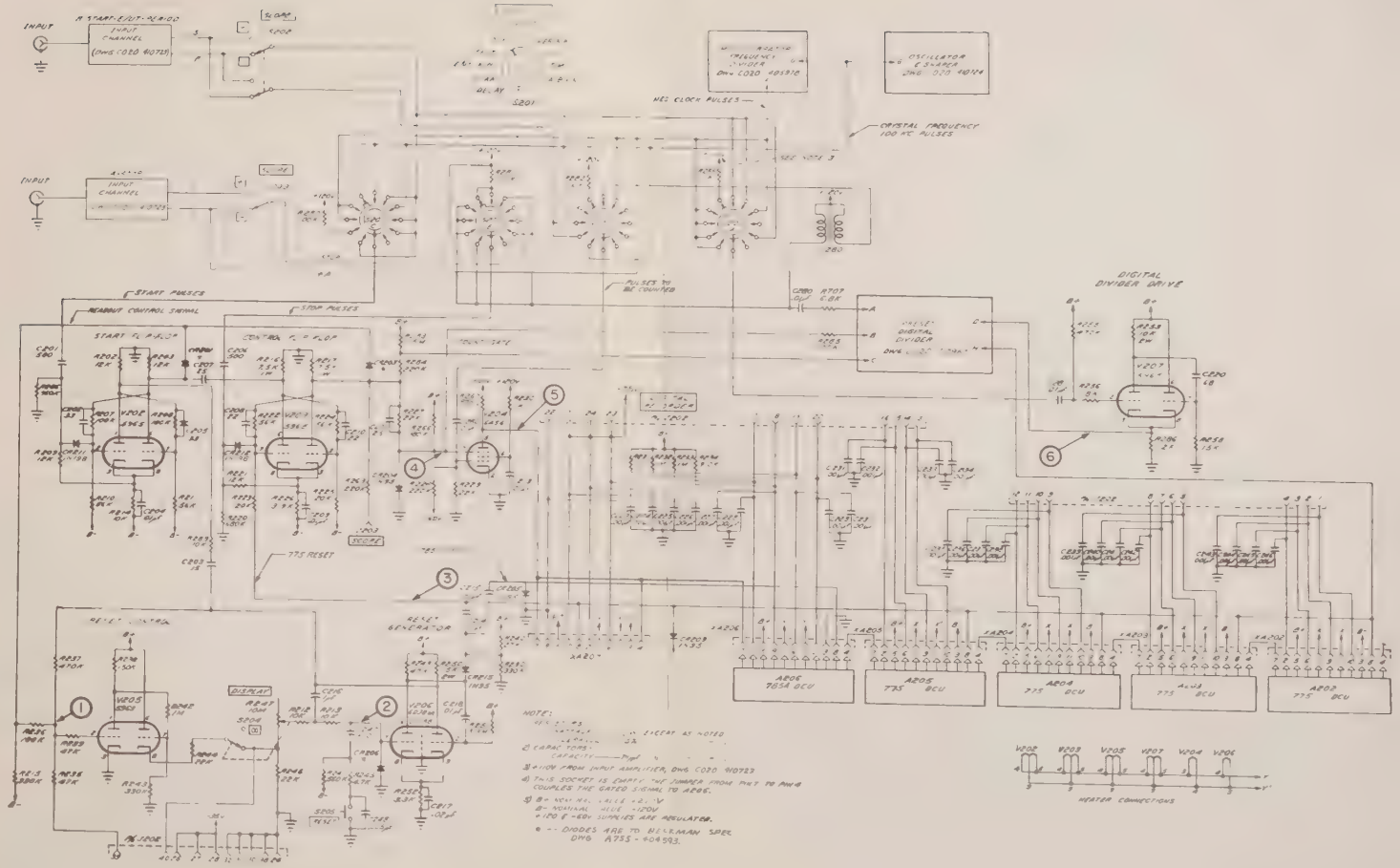
PARTS LIST, MODEL 7351 MASTER SCHEMATIC DIAGRAM

NOTE

The following parts list includes all electrical components except fixed composition resistors whose value, rating, and tolerance are given on the schematic diagram.

Detail No.	Berkeley Stock No.	Description	Manufacturer
C201	804777	Capacitor, mica, 500μμf, 500V, 5%	Sangamo
C202	804744	Capacitor, mica, 33μμf, 500V, 5%	Sangamo
C203	804737	Capacitor, mica, 15μμf, 500V, 5%	Sangamo
C204	804717	Capacitor, ceramic, .01μf, 500V, 20% +80%	Sprague
C205		Same as C202	
C206		Same as C201	
C207	807483	Capacitor, mica, 25μμf, 500V, 5%	Sangamo
C208	804740	Capacitor, mica, 22μμf, 500V, 5%	Sangamo
C209		Same as C204	
C210		Same as C208	
C213		Same as C204	
C214	007467	Capacitor, paper, 0.1μf, 400V, 20%	Hopkins
C216	020338	Capacitor, paper, 1μf, 200V, 20%	Sprague
C217	804722	Capacitor, ceramic, .02μf, 600V, GMV	Erie
C218	804718	Capacitor, ceramic, .01μf, 600V, GMV	Erie
C220	804750	Capacitor, mica, 68μμf, 500V, 5%	Sangamo
C221		Same as C207	
C223 thru C246	804706	Capacitor, ceramic, .001μf, 600V, 20%	Centralab
C247		Same as C201	
C248	804714	Capacitor, ceramic, .005μf, 1000V, 20%	Centralab
C280		Same as C204	
C281		Same as C204	
C282		Same as C204	

Detail No.	Berkeley Stock No.	Description	Manufacturer
CR201	404593	Diode	Beckman/Berkeley
CR203		Same as CR201	
CR204	800272	Diode, 1N95	Hughes
CR206		Same as CR201	
CR209		Same as CR204	
CR211	800274	Diode, 1N198	Hughes
CR212		Same as CR211	
CR215		Same as CR204	
J202	806833	Connector, 40 pin	Cannon
J203	806914	Connector, black nylon	Whitso
R247	806307	Potentiometer, 10M, 1/2W, 10%, w/switch	Centralab
S201	402110	Switch, rotary	Beckman/Berkeley
S202	806040	Switch, toggle, DPDT	Cutler-Hammer
S203		Same as S202	
S204		Switch, part of R247	
S205	043278	Switch, pushbutton, SPDT	Switchcraft
T280	402046	Transformer, pulse	Beckman/Berkeley
V202	800258	Tube, 5965	
V203		Same as V202	
V204	800223	Tube, 6AS6	
V205	800256	Tube, 5963	
V206	800237	Tube, 6DJ8	
V207		Same as V202	
XV202	802336	Tube Socket, 9 pin	Elco
XV203		Same as XV202	
XV204	802323	Tube Socket, 7 pin	Elco
XV205		Same as XV202	
XV206		Same as XV202	
XV207		Same as XV202	
XA202 thru XA206	016990	Socket, 11 pin	Amphenol



Model 7351
D 410-62-Rev. B
January 1963

PARTS LIST FREQUENCY DIVIDERS

NOTE

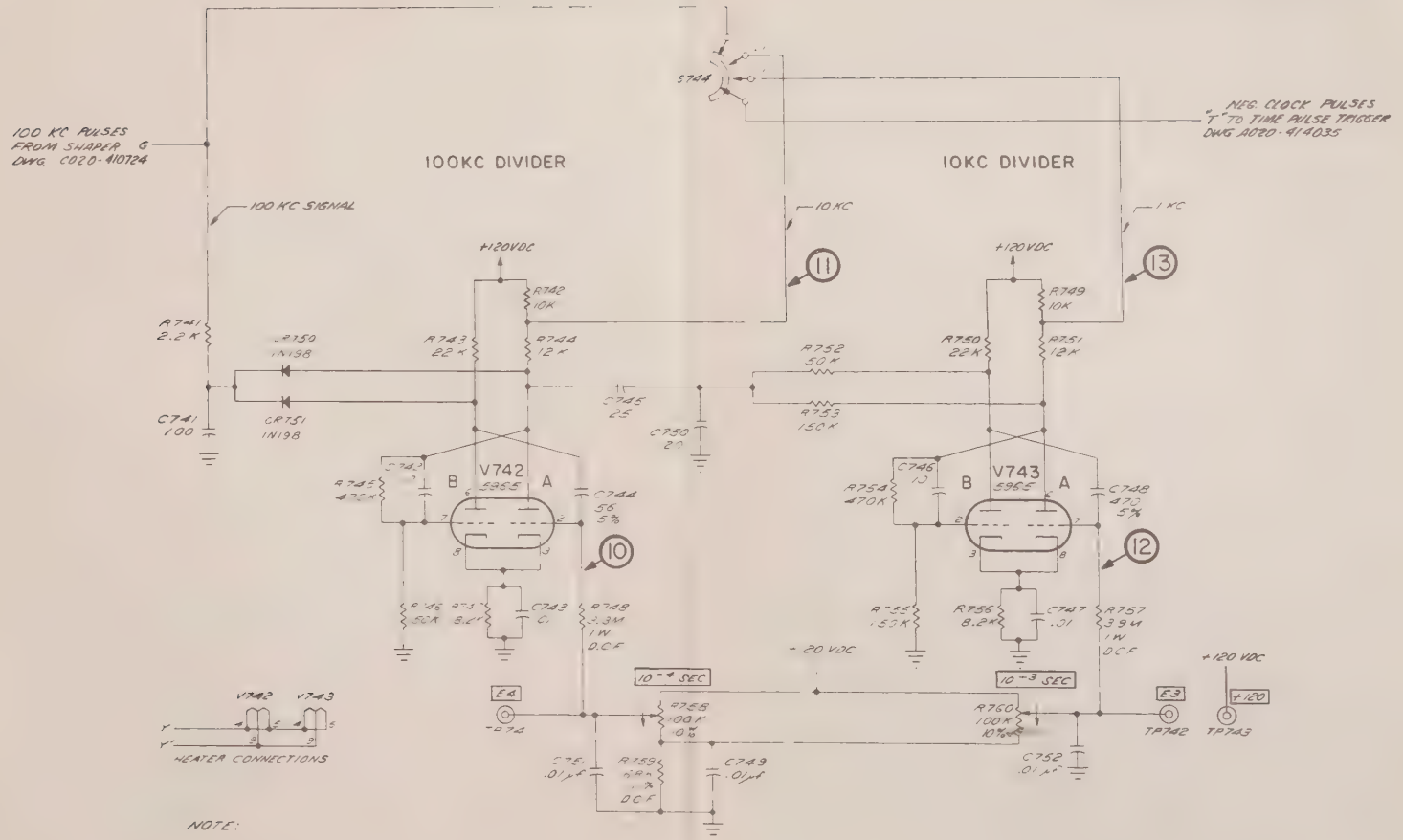
The following parts list includes all electrical components except fixed composition resistors whose value, rating, and tolerance are given on the schematic diagram.

Detail No.	Beckman Stock No.	Description	Manufacturer
C741	807485	Capacitor, mica, 100μμf, 500V, 5%	Sangamo
C742	807482	Capacitor, mica, 10μμf, 500V, 5%	Sangamo
C743	804718	Capacitor, ceramic, .01μf, 450V	Erie
C744	804930	Capacitor, glass, 56μμf, 500V, 5%	Vitramon
C745	807483	Capacitor, mica, 25μμf, 500V, 5%	Sangamo
C746		Same as C742	
C747		Same as C743	
C748	804733	Capacitor, glass, 470μμf, 500V, 5%	Vitramon
C749		Same as C743	
C750		Same as C742	
C751		Same as C743	
C752		Same as C743	
CR750	800274	Diode, 1N198	Hughes
CR751		Same as CR750	
R748	812008	Resistor, 3.9M, 1W, 1%	Electra
R757		Same as R748	
R758	806327	Potentiometer, 100K, 2W, 20%	Allen Bradley
R759	801135	Resistor, 68K, 1W, 5%	Electra
R760		Same as R758	
S744	403439	Switch, rotary	Beckman/Berkeley
T741	801853	Transformer, pulse	Pulse Engineering
T742		Same as T741	
TP741	806915	Connector, tip jack	Whitso
TP742 & TP743		Same as TP741	
V742	800258	Tube, 5965	
V743		Same as V742	
XV742	802336	Socket, 9 pin	Elco
XV743		Same as XV742	

C 405978
December 1961

Beckman

100 KC FREQUENCY DIVIDER SCHEMATIC DIAGRAM

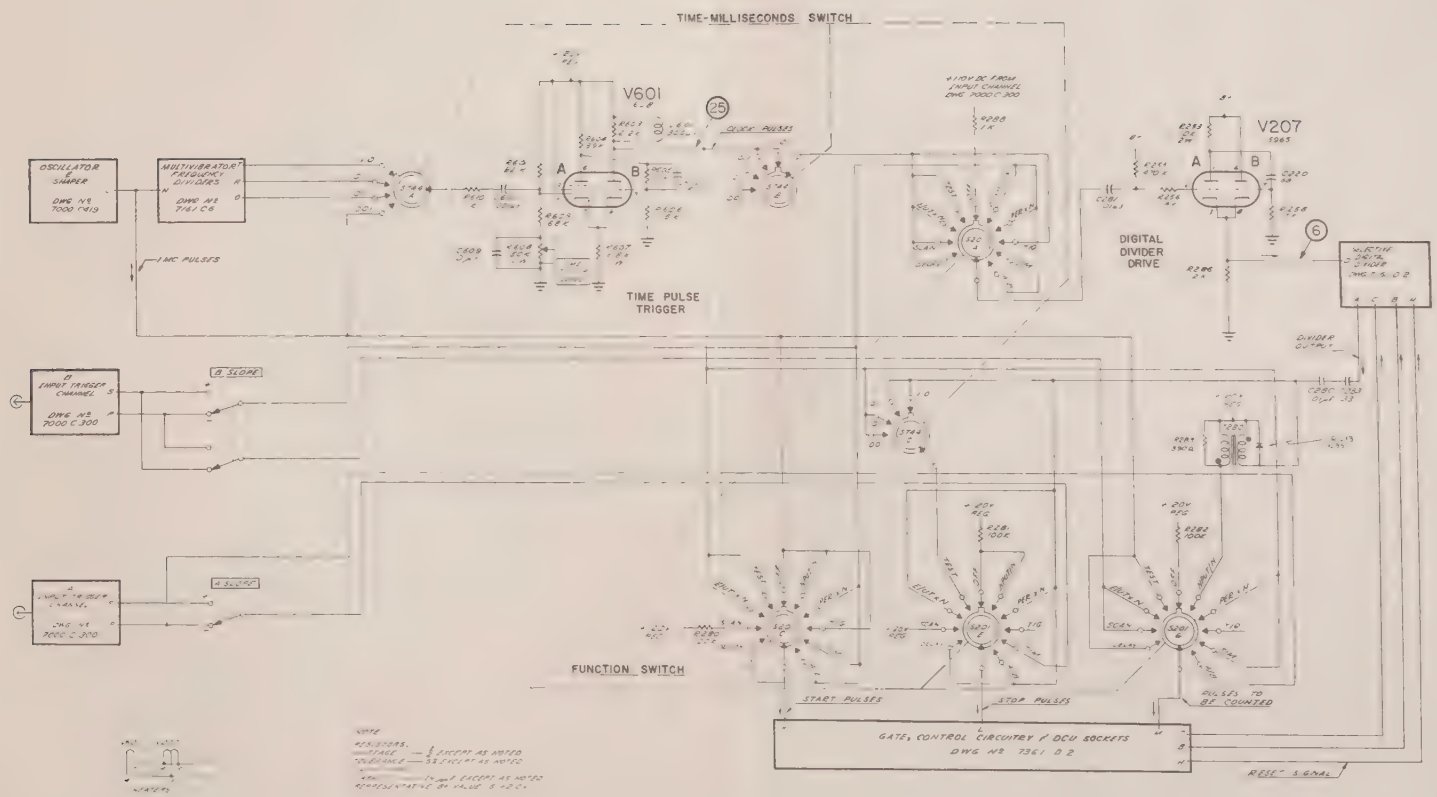


NOTE:

RESISTORS.
WATTAGE——— ½ EXCEPT AS NOTED.
TOLERANCE——— 5% " " "
CAPACITORS:
CAPACITY——— IN μμf " " .

Models:
7151, 7351,
8151, 8351
C 405978 - Rev. B
February 1963

SWITCHING SCHEMATIC DIAGRAM



PARTS LIST, GATE & CONTROL CIRCUITS, MODEL 7161 & 7361

NOTE

The following parts list includes all electrical components except fixed composition resistors whose value, rating, and tolerance are given on the schematic diagram.

Detail No.	Beckman Stock No.	Description	Manufacturer
C201	804777	Capacitor, mica, 500μμf, 500V, 5%	Sangamo
C202	804744	Capacitor, mica, 33μμf, 500V, 5%	Sangamo
C203	804738	Capacitor, mica, 15μμf, 500V, 5%	Sangamo
C204	804717	Capacitor, ceramic, .01μf 500V, -20% +80%	Sprague
C205		Same as C202	
C206	-	Same as C201	
C207	807483	Capacitor, mica, 25μμf, 500V, 5%	Sangamo
C208	804740	Capacitor, mica, 22μμf, 500V, 5%	Sangamo
C209		Same as C204	
C210		Same as C208	
C213		Same as C204	
C214	007467	Capacitor, paper, 0.1μf, 400V, 20%	Hopkins
C215		Same as C214	
C216	020338	Capacitor, paper, 1μf, 200V, 20%	Sprague
C217	804722	Capacitor, ceramic, .02μf, 600V, guaranteed minimum value	Erie
C218	804718	Capacitor, ceramic, .01μf, 450V	Erie
C221		Same as C202	
C223 thru C246	804706	Capacitor, ceramic, .001μf, 600V, 20%	Centralab
C247		Same as C201	

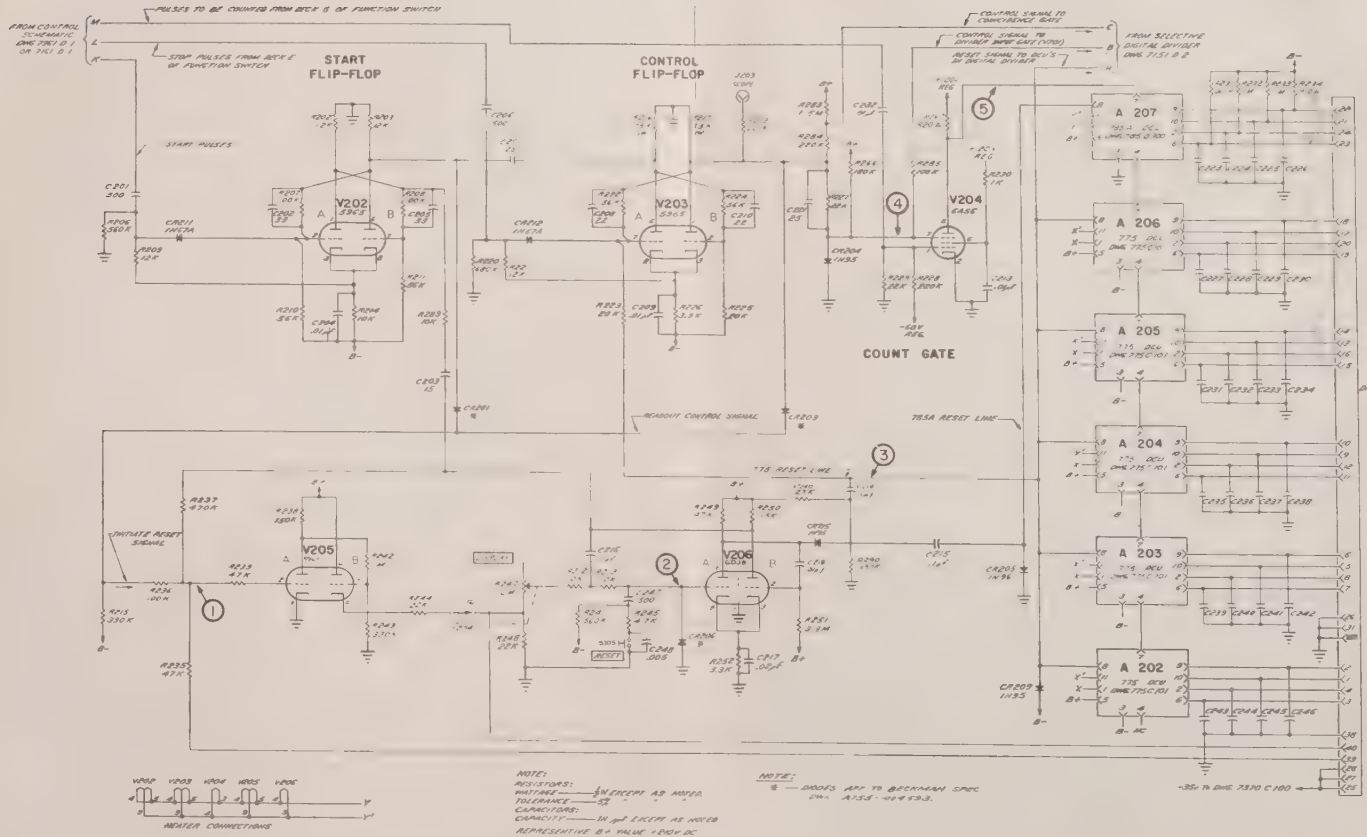
Detail No.	Beckman Stock No.	Description	Manufacturer
C248	804714	Capacitor, ceramic, .005μf, 1000V, 20%	Centralab
C282		Same as C204	
CR201	404593	Diode	Beckman/Berkeley
CR203		Same as CR201	
CR204	800272	Diode, 1N95	Hughes
CR205	800273	Diode, 1N96	Hughes
CR206		Same as CR201	
CR209		Same as CR204	
CR211	800274	Diode, 1N198	Hughes
CR212		Same as CR211	
CR215		Same as CR204	
J202	806833	Connector, 40 pin	Cannon DPX40-33P
J203	806914	Connector, nylon	Whitso
R247	806307	Potentiometer, 10M, 1/2W, 10%, w/switch	Centralab
S204		Switch, see R247	
S205	043278	Switch, pushbutton, SPDT	Switchcraft
V202	800258	Tube, 5965	
V203		Same as V202	
V204	800223	Tube, 6AS6	
V205	800256	Tube, 5963	
V206	800237	Tube, 6DJ8	
XV202	802336	Tube Socket, 9 pin	Elco
XV203		Same as XV202	
XV204	802323	Tube Socket, 7 pin	Elco
XV205		Same as XV202	
XV206		Same as XV205	

Jerry Adams
4-5-62 7330

7361 D 2
December 1961

Beckman

GATE, CONTROL & COUNTING CIRCUIT
MODELS 7161 & 7361
SCHEMATIC DIAGRAM



PARTS LIST, 1 MC FREQUENCY DIVIDER

NOTE

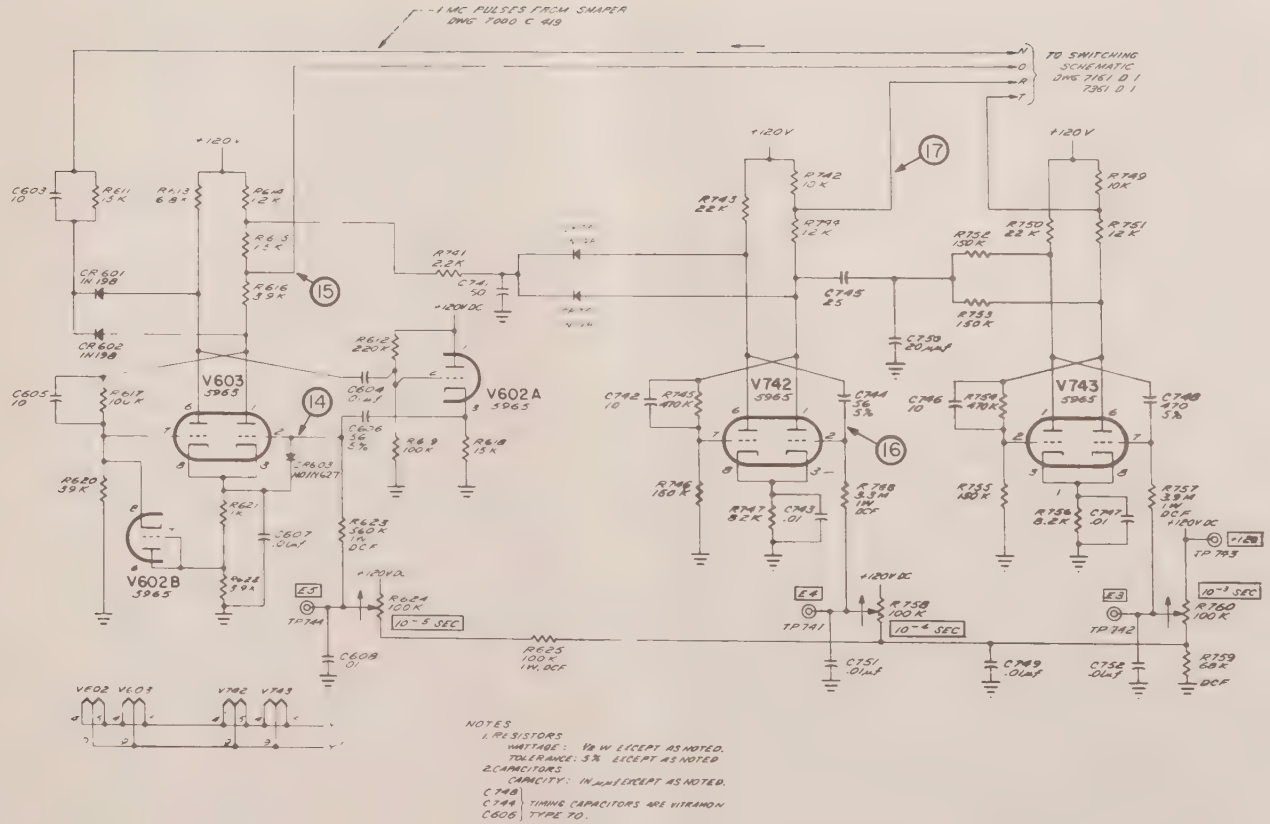
The following parts list includes all electrical components except fixed composition resistors whose value, rating, and tolerance are given on the schematic diagram.

Detail No.	Beckman Stock No.	Description	Manufacturer
C603	807482	Capacitor, mica, 10μμf, 500V, 5%	Sangamo
C604	804718	Capacitor, ceramic, .01μf, 450V	Erie
C605		Same as C603	
C606	804930	Capacitor, glass, 56μμf, 500V, 5%	Vitramon
C607		Same as C604	
C608		Same as C604	
C609		Same as C604	
C741	807484	Capacitor, mica, 50μμf, 500V, 5%	Sangamo
C742		Same as C603	
C743		Same as C604	
C744		Same as C606	
C745	807483	Capacitor, mica, 25μμf, 500V, 5%	Sangamo
C746		Same as C742	
C747		Same as C604	
C748	804733	Capacitor, glass, 470μμf, 500V, 5%	Vitramon
C749		Same as C604	
C750	804739	Capacitor, mica, 20μμf, 500V, 5%	Sangamo
C751		Same as C604	
C752		Same as C604	
CR601	800274	Diode, IN198	Hughes
CR602		Same as CR601	
CR603	402180	Diode	Beckman/Berkeley
CR750		Same as CR601	
CR751		Same as CR601	
R623	812009	Resistor, 560K, 1W, 1%	Electra
R624	806327	Potentiometer, 100K, 2W, 20%	Allen Bradley
R625	801139	Resistor, 100K, 1W, 5%	International
R748	808606	Resistor, 3.3M, 1W, 5%	International
R757	812008	Resistor, 3.9M, 1W, 1%	Electra
R758		Same as R624	
R759	801135	Potentiometer, 68K, 1W, 5%	International
R760		Same as R624	
TP741 thru TP744	806915	Connector, tip jack	Whitso
V602	800258	Tube, 5965	
V603		Same as V602	
V742		Same as V602	
V743		Same as V602	
XV602	802336	Tube Socket, 9 pin	Elco
XV603		Same as XV602	
XV742		Same as XV602	
XV743		Same as XV602	

C 405979
December 1961

Beckman

1 MC FREQUENCY DIVIDER SCHEMATIC DIAGRAM



NOTES
1. RESISTORS
WATTAGE: ½ W EXCEPT AS NOTED.
TOLERANCE: 5% EXCEPT AS NOTED
2. CAPACITORS
CAPACITY: IN μμf EXCEPT AS NOTED.
C748, C744, C606 } TIMING CAPACITORS ARE VITRAMON TYPE 70.

Beckman

PARTS LIST, INPUT CHANNEL

NOTE

The following parts list includes all electrical components except fixed composition resistors whose value, rating, and tolerance are given on the schematic diagram.

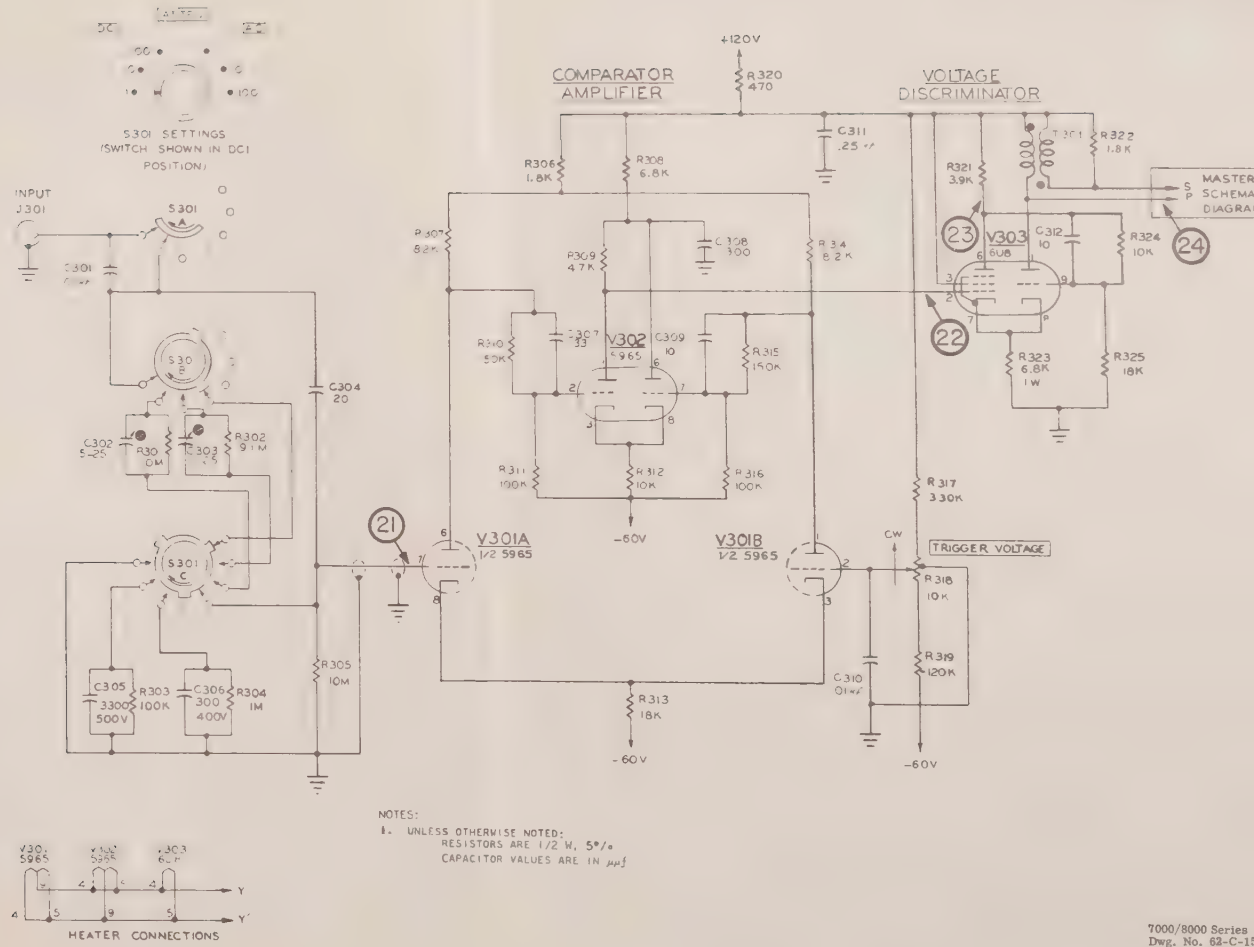
Detail No.	Berkeley Stock No.	Description	Manufacturer
C301	804718	Capacitor, ceramic, .01μf, 600V, guaranteed minimum value	Erie
C302	805005	Capacitor, variable, 5-25μμf, 500V	Erie
C303		Same as C302	
C304	804739	Capacitor, mica, 20μμf, 500V, 5%	Sangamo
C305	804800	Capacitor, mica, 3300μμf, 500V, 5%	Sangamo
C306	804768	Capacitor, mica, 300μμf, 500V, 5%	Sangamo
C307	804744	Capacitor, mica, 33μμf, 500V, 5%	Sangamo
C308		Same as C306	
C309	807482	Capacitor, mica, 10μμf, 500V, 5%	Sangamo
C310		Same as C301	
C311	804871	Capacitor, paper, 0.25μf, 200V, 20%	Hopkins
C312	"	Same as C309	
J301	403555	Connector	Beckman/Berkeley
J302		Same as J301	
R138	812445	Potentiometer, 10K, 2W, 20%	Allen Bradley
S301	402101	Switch	Beckman/Berkeley
T301	402046	Transformer, pulse, 1:1	Beckman/Berkeley
V301	800258	Tube, 5965	
V302		Same as C301	
V303	800240	Tube 6U8	
XV301	802336	Socket, 9 pin	Elco
XV302 & XV303		Same as XV301	

September 1962

Beckman

Dwg. No. 62-C-156

INPUT CHANNEL SCHEMATIC DIAGRAM



7000/8000 Series
Dwg. No. 62-C-15
October 1962

Beckman

PARTS LIST, OSCILLATOR & SHAPER

Refer to Dwg. No. 7000 C 413.

ABBREVIATIONS

BDB	Berkeley Division Beckman, Richmond, Calif.
CRL	Centralab, Milwaukee, Wis.
JFD	JFD Electronics, Brooklyn, N.Y.
AB	Allen-Bradley Company, Milwaukee, Wisconsin

NOTE

The following parts list includes all electrical components except fixed composition resistors whose value, rating, and tolerance are given on the schematic diagram.

Detail No.	Berkeley Stock No.	Description	Mfr. & No.
C401	2-2230	Capacitor, disc, ceramic, .01 μf	Erie 811-.01
*C402	2-2137	Capacitor, silvered mica, 500 μμf	Sangamo RR1350
**C402	2-3068	Capacitor, silvered mica, 180 μμf	Sangamo RR1318
*C403	2-7535	Capacitor, silvered mica, 1200 μμf	Sangamo KR1212
**C403	2-2172	Capacitor, silvered mica, 400 μμf	Sangamo RR1340
*C404	2-3157	Capacitor, silvered mica, 39 μμf	Sangamo RR1439
**C404	2-6065	Capacitor, ceramic, 56μμf, 600V, 5%	Erie NPO
C405		Same as C401	
C406		Same as C401	
C407	2-2135	Capacitor, silvered mica, 15 μμf	Sangamo RR1415
C408		Same as C401	
C409	2-5491	Capacitor, silvered mica, 150 μμf	Sangamo RR1315
*C410	2-5617	Capacitor, variable, 100 μμf	Hammarlund MAPC-101
**C410	2-5706	Capacitor, variable, 2-18 μμf	JFD VC-4
C411	2-4268	Capacitor, electrolytic, 5 μf, 8 v.	Barco PS8-5
C412	2-5793	Capacitor, disc, ceramic, .001 μf	CRL DD102
C413		Same as C412	
**C414	2-2136	Capacitor, silvered mica, 100 μμf	Sangamo DR1310
C415		Same as C401	
C416		Same as C401	
C417	2-5747	Capacitor, paper, metalized, .25 μf	Hopkins MPA .25-200
CR401	8-7274	Diode, 1N198	
J401	17-4985	Test Jack, UG 1094/U	
**L401	3-6328	Inductor, 240 μh	Wilco 3240-15
*L402	3-6397	Inductor, 400 μh	Wilco 1400-15
**L402		Same as L401	
S401	12-1543	Switch, toggle, SPST	BDB
V401	5-2526	Tube, 6U8	Sylvania
V402		Same as V401	
XV401	4-2973	Tube Socket, 9 pin, min.	Elco 377BC
XV402		Same as XV401	
XY401	4-3213	Crystal Socket, octal mica filled	Cinch 16203
*Y401	13-6325	Crystal, 100 kc, w/oven	BDB
**Y401	13-5696	Crystal, 1 mc, w/oven	BDB

ADDITIONS

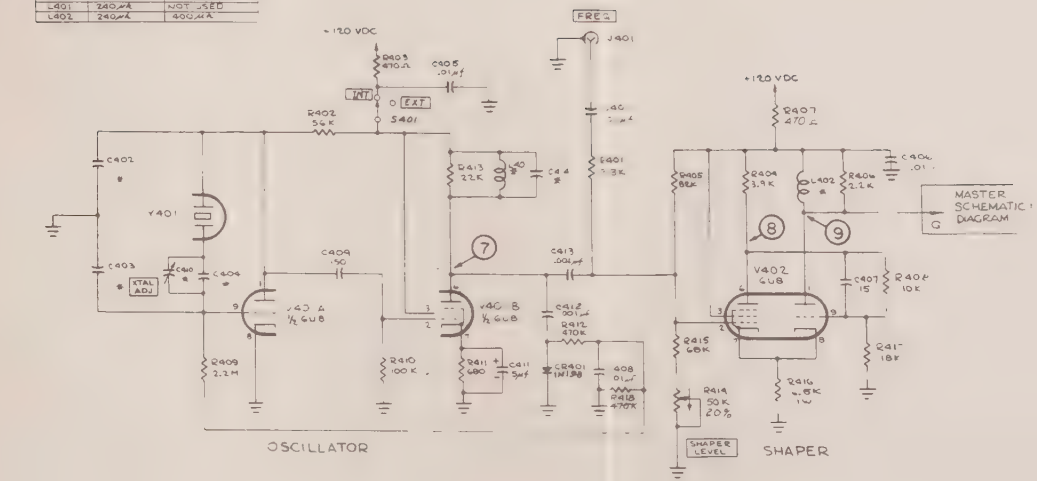
I401	21-1677	Lamp	General Electric 47
R414	1-2318	Potentiometer, 50K, 2W, 20%	AB JU5032-SD3048
XI401	4-3324	Socket, lamp	Drake 101

*For instruments using 100 kc crystal.
**For instruments using 1 mc crystal

OSCILLATOR AND SHAPER SCHEMATIC DIAGRAM

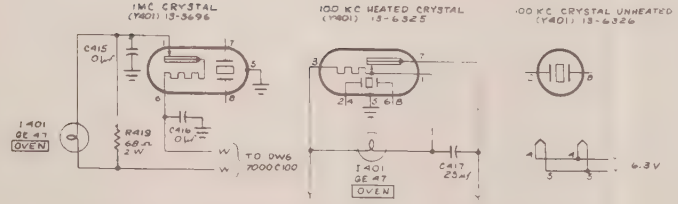
*COMPONENT VALUES ARE AS LISTED BELOW

COMP	WITH 1 MC XTAL	WITH 100 KC XTAL
C402	180 μμf	500 μμf
C403	400 μμf	1200 μμf
C409	56 μμf (NOM)	39 μμf (NOM)
C410	2-18 μμf	60 μμf
C414	100 μμf	NOT USED
L401	240 μh	NOT USED
L402	240 μh	400 μh



NOTE:
1. RESISTORS:
WATTAGE - ½W UNLESS OTHERWISE NOTED
TOLERANCE - 10% " "
2. CAPACITORS:-
CAPACITY - IN μμf UNLESS OTHERWISE NOTED

62-B-102



PARTS LIST, PRESET DIGITAL DIVIDER

NOTE

The following parts list includes all electrical components except fixed composition resistors whose value, rating, and tolerance are given on the schematic diagram.

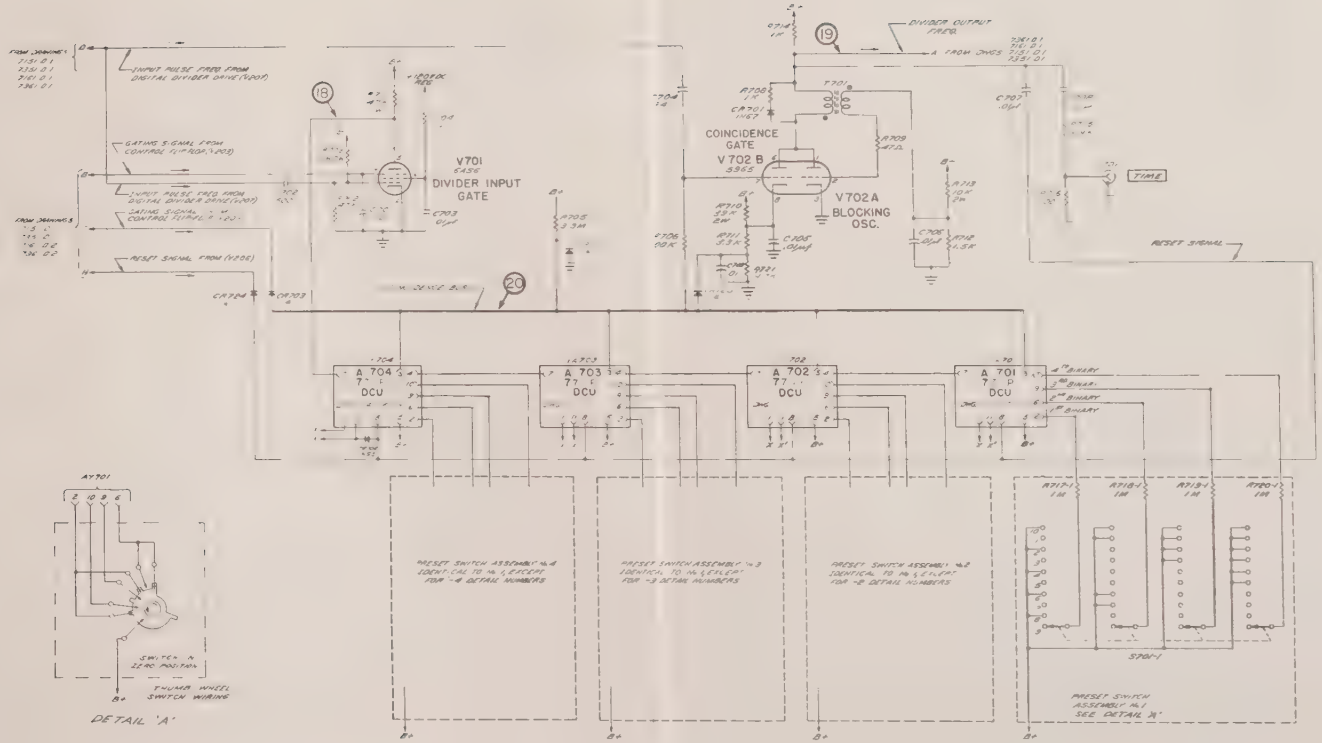
Detail No.	Beckman Stock No.	Description	Manufacturer
C701	807485	Capacitor, mica, 100μμf, 500V, 5%	Sangamo
C702	804777	Capacitor, mica, 500μμf, 500V, 5%	Sangamo
C703	804718	Capacitor, ceramic, .01μf, 450V	Erie
C704	804741	Capacitor, mica, 24μμf 500V, 5%	Sangamo
C705		Same as C703	
C706		Same as C703	
C707		Same as C703	
C708		Same as C703	
C709	804717	Capacitor, ceramic, .01μf, 500V, +80% -20%	Sprague
CR701	800274	Diode, 1N198	Hughes

Detail No.	Berkeley Stock No.	Description	Manufacturer
CR702	404593	Diode	Beckman/Berkeley
CR703		Same as CR702	
CR704	800272	Diode, 1N95	Hughes
CR724		Same as CR702	
CR725		Same as CR702	
J701	806738	Connector	Cannon
S701	402065	Switch, rotary	Beckman/Berkeley
T701	402109	Transformer, pulse	Beckman/Berkeley
V701	800223	Tube, 6AS6	
V702	800258	Tube, 5965	
XV701	802323	Tube Socket, 7 pin	Elco
XV702	802336	Tube Socket, 9 pin	Elco

7151 D 2
December 1961

Beckman

PRESET DIGITAL DIVIDER SCHEMATIC DIAGRAM


V701
6AS6
DIVIDER INPUT GATE
COINCIDENCE GATE
V 702 B
5965
V702 A
BLOCKING OSC.
DIVIDER OUTPUT FREQ.
TIME
RESET SIGNAL
A 704 77 DCU
A 703 77 DCU
A 702 77 DCU
A 701 77 P DCU
PRESET SWITCH ASSEMBLY #4 IDENTICAL TO #1, EXCEPT FOR -4 DETAIL NUMBERS
PRESET SWITCH ASSEMBLY #3 IDENTICAL TO #1, EXCEPT FOR -3 DETAIL NUMBERS
PRESET SWITCH ASSEMBLY #2 IDENTICAL TO #1, EXCEPT FOR -2 DETAIL NUMBERS
PRESET SWITCH ASSEMBLY #1 SEE DETAIL 'A'
DETAIL 'A'
THUMB WHEEL SWITCH WIRING
HEATER CONNECTIONS

NOTE
RES & CAPS
WATTAGE — ½W, EXCEPT AS NOTED
TOLERANCE — 5%, " " "
CAPACITY — IN μμf.
NOMINAL — B+ VALUE +200V DC.
NOMINAL — B- VALUE -100V DC.
X = FILAMENT
X' = FILAMENT B- CONNECTION
* — DIODES ARE TO BECKMAN SPEC. DWG. A755-404593.

7000 Series
7151 D 2-Rev. L
July 1962

Beckman

PARTS LIST, POWER SUPPLY

Refer to Dwg. No. 7370-62-C-47

NOTE

The following parts list includes all electrical components except fixed composition resistors whose value, rating, and tolerance are given on the schematic diagram.

ABBREVIATIONS

AB	Allen Bradley Co., Milwaukee, Wis.
B/B	Beckman/Berkeley, Richmond, California
CH	Cutler-Hammer Co., Milwaukee, Wis.
WW	Wirewound

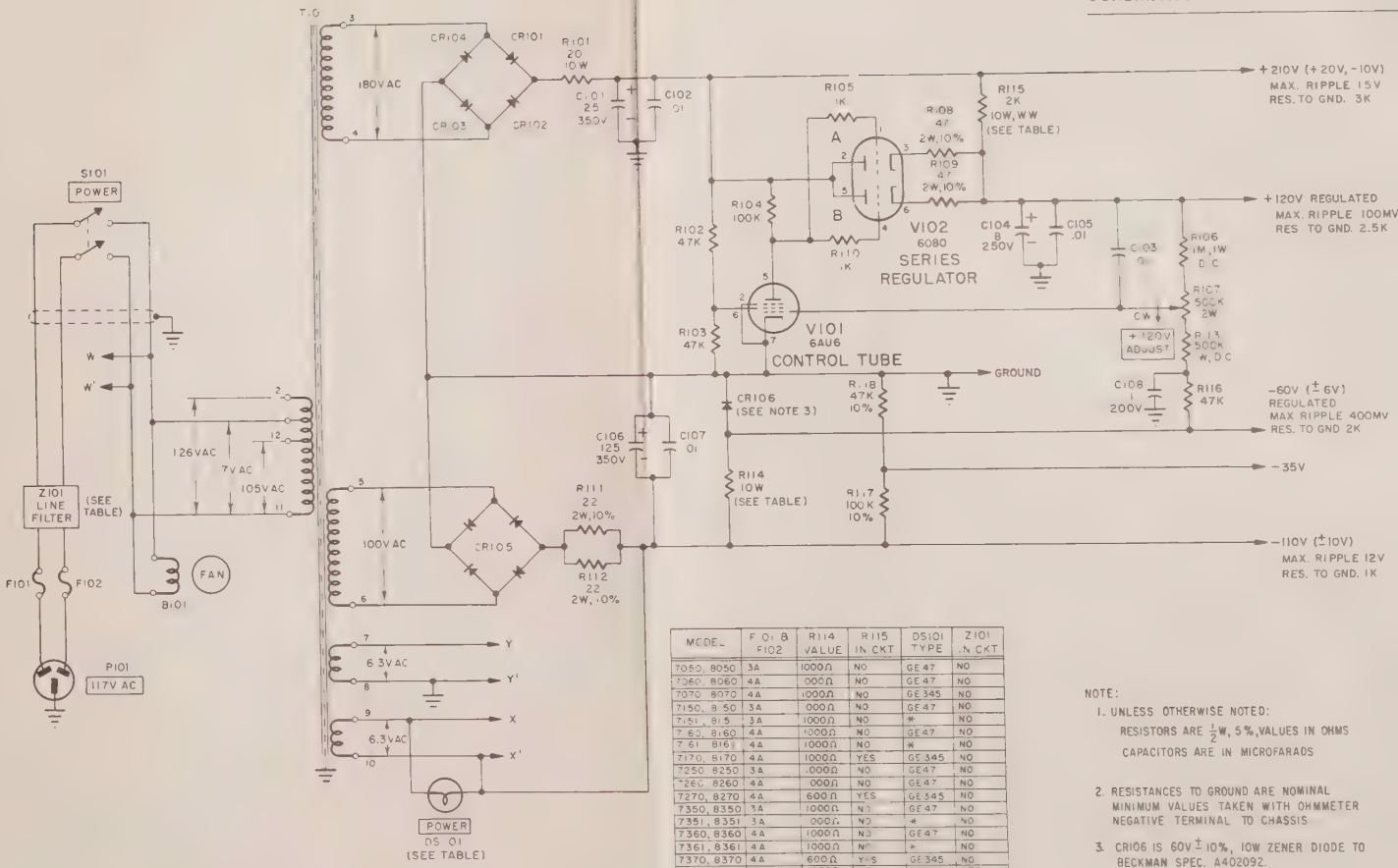
Detail No.	Berkeley Stock No.	Description	Manufacturer & No.
B101	407587	Fan Assembly	B/B
C101	802975	Capacitor, 125μf, 350V	Mallory FP140
C102	804718	Capacitor, disc., .01μf	Erie 811-.01
C103		Same as C102	
C104	802946	Capacitor, electrolytic, 8μf, 250V	Sangamo MT 2508
C105		Same as C102	
C106		Same as C101	
C107		Same as C102	
C108	091715	Capacitor, 0.1μf, 200V, 20%	Sangamo 330201
CR101	023744	Rectifier, silicon	Sarkes Tarzian M500
CR102		Same as CR101	
CR103		Same as CR101	
CR104		Same as CR101	
CR105	808191	Rectifier, 110V, 130ma	General Electric 6R21PB3AT1
CR106	402092	Diode	B/B
DS101*	802507	Lamp	General Electric #345
	063063	Lamp	General Electric #47
F101*	801574	Fuse, SloBlo, 3 amp. 125V	Littelfuse
	801579	Fuse, SloBlo, 4 amp. 125V	Littelfuse
F102		Same as F101	

Detail No.	Berkeley Stock No.	Description	Manufacturer & No.
R101	800932	Resistor, 20Ω, 10W	Tru-Ohm FRL-10
R108	800913	Resistor, 1M, 1W	Arnhold Ceramics Stemag Type A2
R107	806335	Potentiometer, 500K, 2W	AB JU 5041 SD3048
R113	801148	Resistor, 500K, 1W	Arnhold Ceramics Stemag Type A2
R114*	802000	Resistor, WW, 1000Ω, 10W, 10%	Tru-Ohm FRL-10
	002775	Resistor, WW, 600Ω, 10W	Tru-Ohm FRL-10
R115	800941	Resistor, WW, 2K, 10W	Tru-Ohm FRL-10
S101	806031	Switch, toggle, DPST	CH 8370 K8
T101	402952	Transformer, power	B/B
V101	015096	Tube, 6AU6	
V102	020285	Tube, 6080	
XCR101	024849	Spring Clip	Littelfuse 099062
XCR102 thru XCR104		Same as XCR101	
XDS101*	801191	Lamp Socket Assy. w/green lens	Dialight Corp. 81410-432
	817545	Lamp Socket Assy. w/green lens	Dialight Corp. 111-3830-112
XF101	007268	Fuse Post	Bussman HKP
XF102		Same as XF101	
XV101	802323	Tube Socket, 7 pin	Elco 316BC
XV102	802331	Tube Socket, octal	Cinch 9950
Z101	802473	Line Filter	Sprague 64864

*Type or value depends on instrument model. See table on Power Supply Schematic Diagram.

June 1962

POWER SUPPLY SCHEMATIC DIAGRAM



MODEL	F 01 & F102	R114 VALUE	R115 IN CKT	DS101 TYPE	Z101 IN CKT
7050, 8050	3A	1000Ω	NO	GE 47	NO
7060, 8060	4A	000Ω	NO	GE 47	NO
7070 8070	4A	1000Ω	NO	GE 345	NO
7150, 8150	3A	000Ω	NO	GE 47	NO
7151, 8151	3A	1000Ω	NO	*	NO
7160, 8160	4A	1000Ω	NO	GE 47	NO
7161 8161	4A	1000Ω	NO	*	NO
7170, 8170	4A	1000Ω	YES	GE 345	NO
7250 8250	3A	.000Ω	NO	GE 47	NO
7260 8260	4A	000Ω	NO	GE 47	NO
7270, 8270	4A	600Ω	YES	GE 345	NO
7350, 8350	3A	1000Ω	NO	GE 47	NO
7351, 8351	3A	000Ω	NO	*	NO
7360, 8360	4A	1000Ω	NO	GE 47	NO
7361, 8361	4A	1000Ω	NO	*	NO
7370, 8370	4A	600Ω	YES	GE 345	NO
5571	4A	1000Ω	NO	GE 47	YES
7413 TO 7416	4A	1000Ω	NO	GE 47	YES
7423 TO 7426	4A	1000Ω	NO	GE 47	YES
7152 & 7153	3A	000Ω	NO	*	NO
7175, 8175	4A	600Ω	YES	GE 345	NO

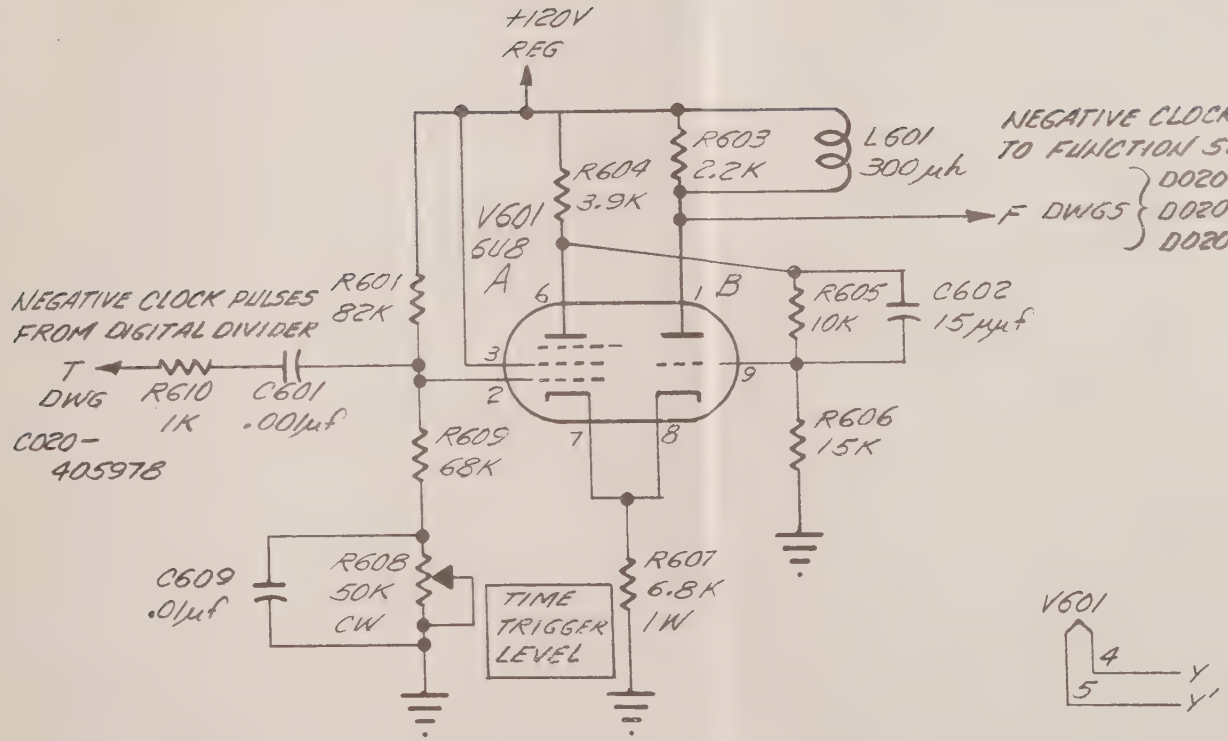
* NO LAMP USED

NOTE:

1. UNLESS OTHERWISE NOTED:
   RESISTORS ARE ½W, 5%, VALUES IN OHMS
   CAPACITORS ARE IN MICROFARADS
2. RESISTANCES TO GROUND ARE NOMINAL MINIMUM VALUES TAKEN WITH OHMMETER NEGATIVE TERMINAL TO CHASSIS
3. CR106 IS 60V ±10%, 10W ZENER DIODE TO BECKMAN SPEC. A402092.

7000/8000 Series
7370-62-C-47 Rev. 3
October 1962

Beckman



NOTE:
RESISTORS:
WATTAGE 1/2W EXCEPT AS NOTED.
TOLERANCE 5% " " " .

Models:
7151, 7351,
8151, 8351
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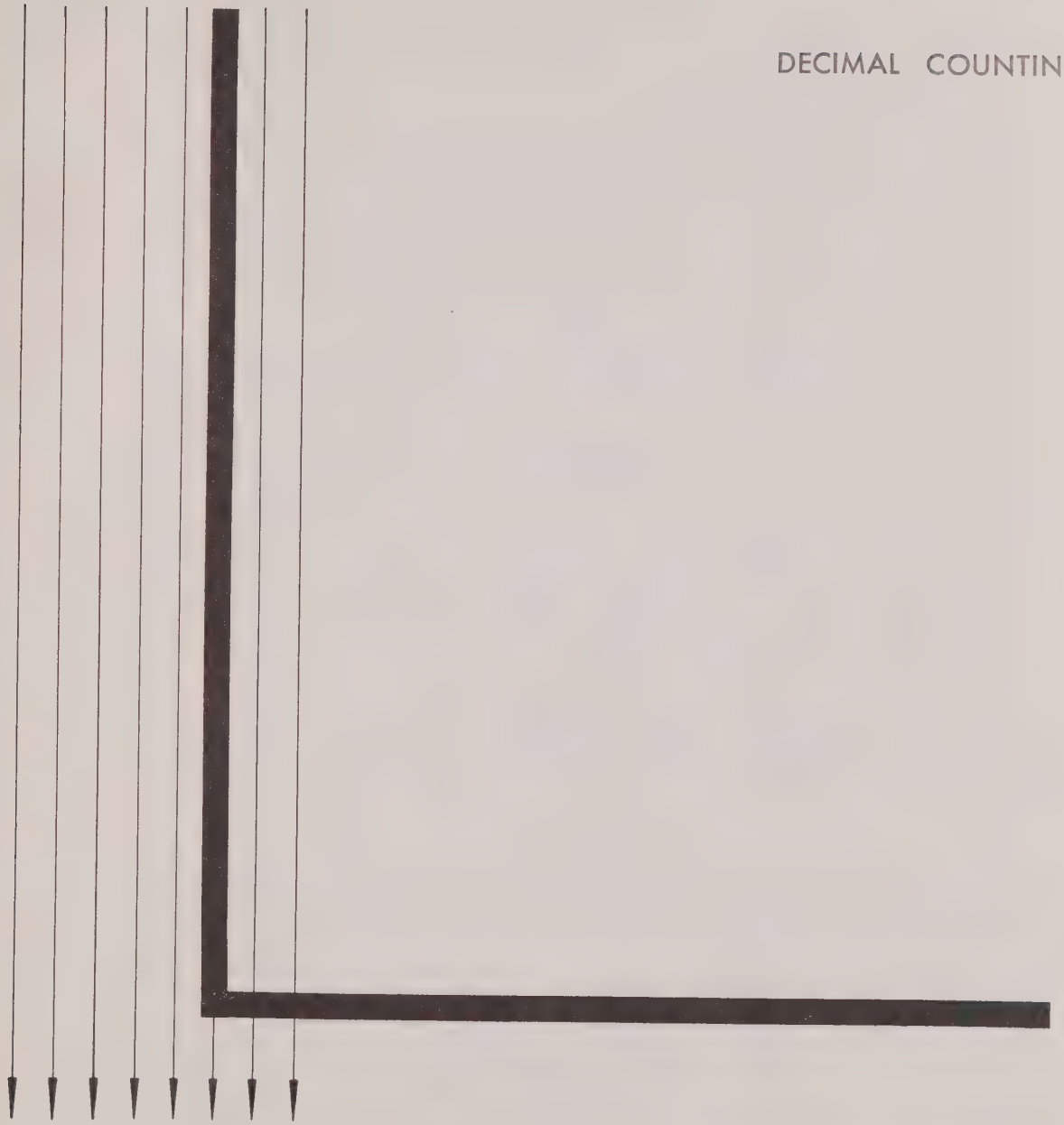
Beckman

INSTRUCTION MANUAL

MODEL 785A

DECIMAL COUNTING UNIT



Beckman® INSTRUMENTS, INC.

BERKELEY DIVISION
2200 Wright Avenue
Richmond, California

1960

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Experienced service personnel and special test equipment are available at the factory to perform any necessary repairs. Every effort will be made to expedite the repair of instruments returned for servicing. Repair work will be performed only upon receipt of a written purchase order or authorization. Instruments to be repaired should be addressed to SERVICE AND REPAIR DEPARTMENT with transportation charges prepaid. Repaired instruments will be returned to the purchaser with transportation charges collect.

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Model 785A Schematic Diagram (D 402889-Rev. F)

GENERAL DESCRIPTION

The Model 785A is a direct-reading, plug-in decimal counting unit. A decimal counting unit (DCU) registers voltage pulses applied at an input. Starting from zero it counts to nine, returning to zero on the tenth pulse and simultaneously generating an output signal. The count score is indicated by the illumination of one of ten neon lights placed behind a numbered acetate panel. This unit will count at a maximum rate of 1, 100, 000 pulses per second. This output is suitable for driving a Model 775 DCU or any modification of it (775AJ, 775K, etc.) except a 775LJ. Decimal counting units may be connected in cascade (output of one to input of next), thus forming a counter whose total capacity depends only on the number of units in the chain. For example, a chain consisting of one 785A followed by five 775's will count to 999, 999, returning to "000, 000" on the 1, 000, 000th input pulse.

The unit also generates a binary-coded decimal readout in the form of high or low voltages at each of four pins on the DCU plug.

SPECIFICATIONS

Count Indication

Illuminated decimal digits

Input Requirements

Negative pulses. (See "OPERATION")

Resolution of Paired Pulses

0.8 microseconds

Maximum Counting Rate

1, 100, 000 counts per second

Output Characteristics

Designed to drive a Model 775 DCU or any modification of it except a 775LJ. (See "OPERATION".)

NOTE: The 785A will also drive the 705 series DCU's since the latter are interchangeable with the 775 series.

Reset

Reset to zero by negative pulse applied to pin 8 of plug.

Power Requirements

Heaters: 6.3V a-c at 1.8 amps near ground potential.

Plates

175 to 260 volts. (Design center is 210 volts at 45 ma.)

Construction

Plug-in unit which fits into standard 11-pin tube socket.

Dimensions

1-3/8" by 5" by 5-3/8"

Weight

1 pound

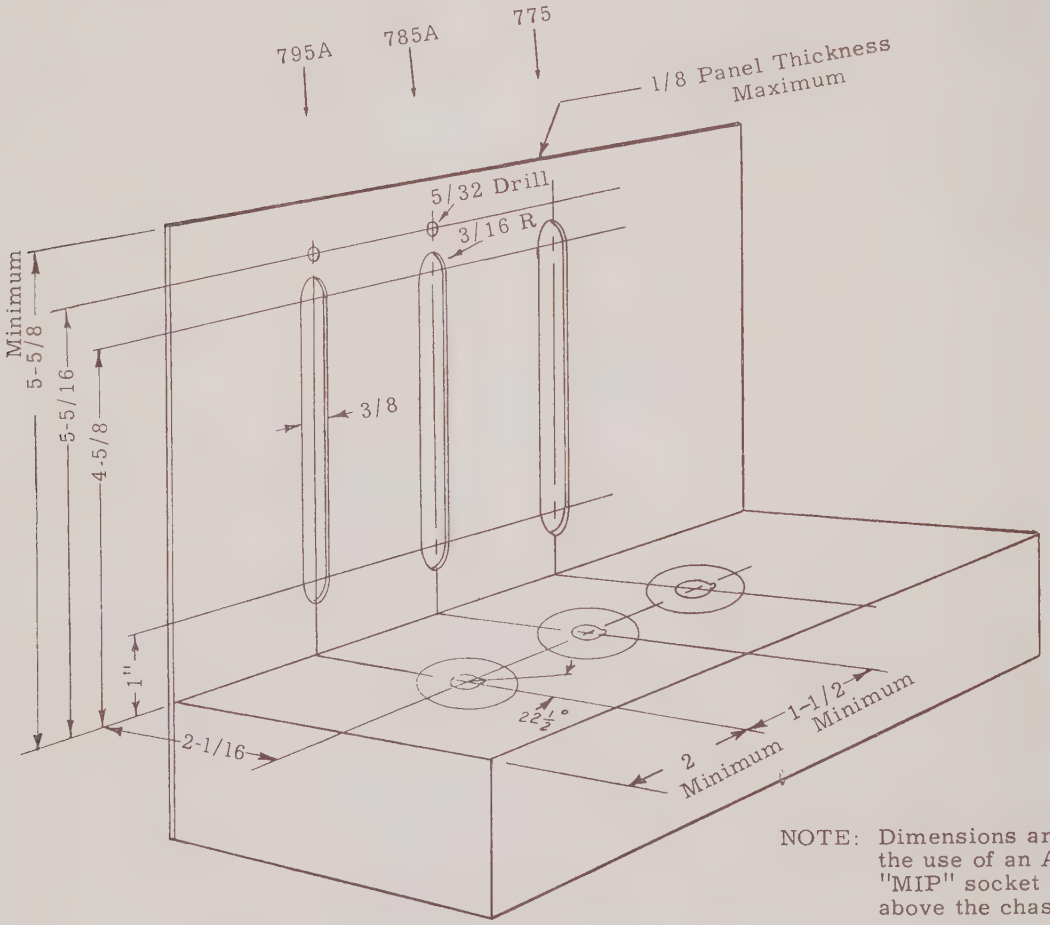
Tube Complement

Four type 12AV7.

INSTALLATION AND OPERATION

When purchased as part of another instrument, the decimal counting units are fully installed and ready to function. DCU's purchased separately should be installed and operated in accordance with the directions that follow.

Mounting. Figure 1 shows the dimensions of a chassis suitable for mounting one of these DCU's together with a Model 795A (10MC) and a Model 775 (100KC).



NOTE: Dimensions are based on the use of an Amphenol "MIP" socket mounted above the chassis.

The drawing shows the chassis dimensions for mounting Models 795A, 785A, and 775 DCU's side by side. Spacing between all units (or additional units) is identical.

FIGURE 1.

MOUNTING DIMENSIONS FOR MODEL 785A OR 795A DECIMAL COUNTING UNIT

INPUT REQUIREMENTS

A negative pulse of 7 volts peak amplitude is required to trigger the unit. The rise time should be less than 0.12 microseconds, and the duration at least 0.25 microseconds. When the unit is powered by an unregulated supply, the drive amplitude should be proportional to the actual B+ voltage.

OUTPUT CHARACTERISTICS

The output is a rectangular waveform as shown in Figure 4. It is represented at the output terminal as a change in direct current voltage level. During count display "0" thru "3" it is 115 volts; during count display "4" thru "9", 205 volts. Ordinarily, the 90-volt negative transient produced at the count of ten drives the following decimal counting unit.

The load imposed on a unit must not be more than a 27,000 ohm resistor in series with a 39 $\mu\mu$f capacitor to ground.

METHOD OF RESET

Regardless of the number of units, all may be set back to zero by applying a negative pulse to a common line connected to pin 8 of the 11-pin socket.

BINARY CODE READOUT

The output at pins 2, 6, 9, and 10 of the DCU plug may be used to operate another binary coded readout or printing device. Refer to the Binary Readout Code table on page 6 to learn the relationship between binary digits and plug terminal pins.

CIRCUIT DESCRIPTION

THE BINARIES

The Model 785A DCU contains four "flip-flop" circuits referred to here as binaries. These circuits are modifications of the Eccles-Jordan trigger circuit.

Figure 2 shows a typical binary. It consists of two triode voltage amplifiers with the plate of each direct-coupled to the grid of the other. With no input this circuit assumes one of two stable states: V1 conducting steadily and V2 cut off, or V2 conducting and V1 cut off. Suppose V1 is not conducting; then its plate is near the B+ voltage. A portion of this voltage, applied to the grid of V2 through the voltage dividing network R4 and R8, raises this grid above cutoff and permits V2 to conduct. While V2 is conducting, the low positive potential at its plate, coupled to the grid of V1 through the dividing network R3 and R7, holds this grid several volts below cutoff. Since small changes in the potential at the grid

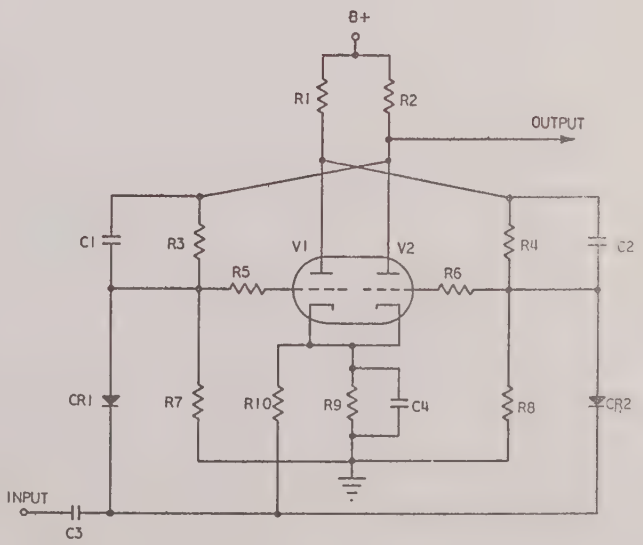


FIGURE 2.

A TYPICAL BINARY STAGE

of V1 will not raise it above cutoff, this state is stable and will persist until disturbed by an appreciable input signal. Notice that, since the circuit is symmetrical, the opposite state is equally stable.

The circuit is triggered from one state to another by negative transients applied at the input. The input diodes CR1 and CR2 form a gating system which couples the pulse formed at C3 to the grid of the conducting triode but blocks it from the grid of the other triode. Suppose, as before, that V1 is cut off and V2 is conducting. The diode side of C3 will carry a potential of about 40 volts (the same as that on the grid of V2). An applied transient will cause this potential to drop momentarily toward 30 volts. CR1 will not conduct since its plate is negative of 30 volts. However CR2 will conduct and the negative transient at the grid of V2 will lower tube current and cause an amplified rise in plate voltage. This rise will carry the grid of V1 above cutoff. The moment V1 conducts, the drop in voltage at its plate, coupled to the opposite grid, reinforces the negative transient there. This regenerative action proceeds rapidly until V2 is cut off and V1 is conducting at a steady rate. The next adequate input transient causes a reverse action and returns the binary to its original state. Thus, the binary completes a cycle for every two input transients applied, making it a scale of two. The output is the drop in voltage at one of the plates as that triode begins to conduct. This output, consisting of one negative transient for every two input transients, is suitable for driving another binary. By connecting binaries in cascade (output of one to input of the next), a counter having a scale of any power of two can be built. A chain of three cascaded binaries would be a scale-of-eight (2^3). If we call the input pulses driving such a chain "counts", the operation may be described as follows. The first binary will produce a negative pulse upon counts 2, 4, 6 and 8. The second binary will generate output pulses at counts 4 and 8, and the third binary will produce a pulse only at count 8. Count 8 completes a full cycle; the binaries will then be in the same state they were in before the first count.

THE SCALE OF TEN

In the Model 785A three binaries are connected in cascade to form a scale of eight. A fourth binary is arranged to block the input to the second binary during two input pulses to the counter, so that ten rather than eight pulses are required to produce a complete cycle. Figure 3 is a block diagram of the circuit.

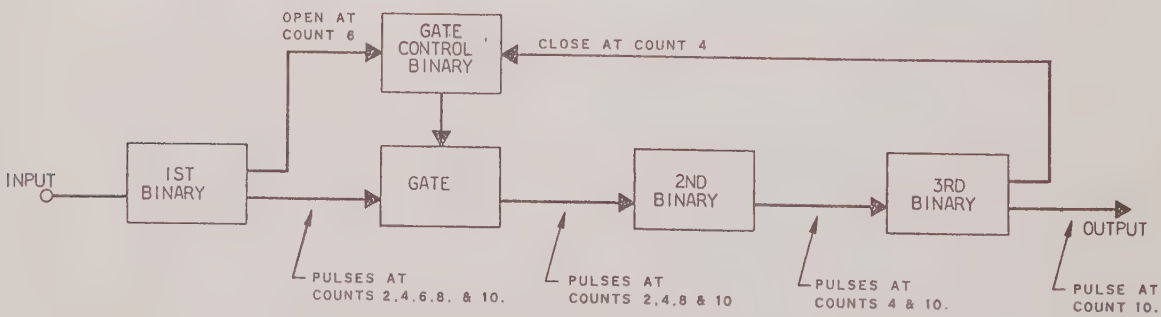


FIGURE 3.
BLOCK DIAGRAM OF MODEL 785A DCU

At the beginning of a cycle the gate control binary is in the state which holds the gate open. For the first three counts (that is, counts "1" through "3") the unit operates like a simple binary counter. At count 4 the third binary is triggered for the first time and, in turn triggers the gate control binary to its other state, closing the gate. The gate is closed during counts 5 and 6. At count 6 the first binary produces an output pulse which triggers the gate control binary back to the "open" state. During counts 7, 8, 9, and 10 the unit again operates like a simple binary chain. At count 10 the third binary produces a negative output transient which will drive another decimal counting unit.

TABLE 1

Count Display	State of Each Binary Stage			
	4th	3rd	2nd	1st
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	1	1	0	0
5	1	1	0	1
6	0	1	0	0
7	0	1	0	1
8	0	1	1	0
9	0	1	1	1
0	0	0	0	0

The operating sequence of the DCU is summarized in Table 1 which shows the state of each binary for each registered count score. The state of a binary is defined by whether or not triode B is conducting. "0" means triode B is conducting; "1" means triode B is cut off.

Figure 4 shows how voltages throughout the unit change as successive input pulses are received. Voltages are identified by circled reference points located on the schematic diagram. The output voltage used to drive succeeding binaries is taken from the junction of two plate load resistors in the right-hand triode circuit rather than from the plate itself.

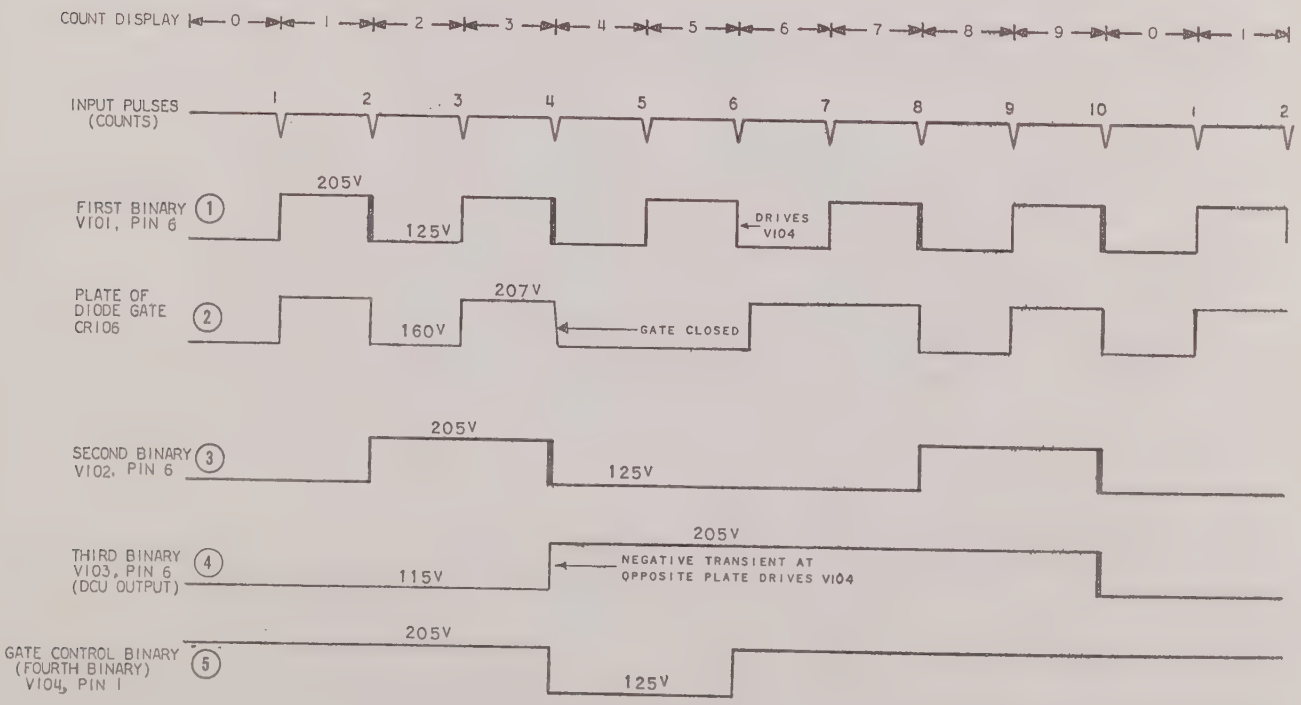

COUNT DISPLAY 0 1 2 3 4 5 6 7 8 9 0 1
INPUT PULSES (COUNTS) 1 2 3 4 5 6 7 8 9 10 1 2
FIRST BINARY V101, PIN 6 (1)
205V
125V
DRIVES V104
PLATE OF DIODE GATE CR106 (2)
207V
160V
GATE CLOSED
SECOND BINARY V102, PIN 6 (3)
205V
125V
THIRD BINARY V103, PIN 6 (DCU OUTPUT) (4)
205V
115V
NEGATIVE TRANSIENT AT OPPOSITE PLATE DRIVES V104
GATE CONTROL BINARY (FOURTH BINARY) V104, PIN 1 (5)
205V
125V

FIGURE 4.

IDEALIZED WAVEFORMS

The waveforms at this junction are identical to the plate waveforms shown in Figure 4, but of smaller amplitude. The negative transients (shown in heavy lines in Figure 4) drive succeeding binaries. The negative transient from the first binary which occurs at count 6 does not reach the second binary because of the action of the gate diode CR106 described in the paragraph "Gate Control Circuit".

Actual oscilloscope waveforms are shown in Figure 8. Each photograph has a number corresponding to the point on the schematic diagram where the waveform was observed.

BINARY CODE READOUT

The output voltages of each binary are also brought out to pins 2, 6, 9 and 10 of the DCU plug to operate auxiliary binary-coded readout devices. Observe that voltage at pin 6 combines the output of the second binary and the output of the right half of the fourth binary while the voltage at pin 10 combines the output of the third binary with that of the left half of the fourth binary. The resultant modified binary code given in Table 2 below agrees with that generated by other Beckman instruments. In the table, "0" represents a voltage of -15 volts or more negative; "1" represents a voltage at ground level or more positive.

TABLE 2. BINARY READOUT CODE

Count Display	Pin on DCU Plug			
	10	9	6	2
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	1	0
5	0	1	1	1
6	1	1	0	0
7	1	1	0	1
8	1	1	1	0
9	1	1	1	1
0	0	0	0	0

GATE CONTROL CIRCUIT

At count 4, the voltage at the right plate of the third binary (Point (4) on the schematic) rises. At the same time, the voltage at the left plate drops. The negative transient produced at the left plate is coupled to the right grid of the gate control binary (V104), causing it to switch to the state in which the left triode conducts. (Point (5)). The resultant voltage drop across R119 causes the plate of the diode gate (CR106) to drop to +160v. (Point (2)). At this time the diode plate voltage is equal to its cathode voltage, which varies between +207v and +160v. The diode does not conduct and therefore prevents the negative output transient at count 6 from reaching the second binary. However, the negative output pulse of V101 is coupled through C104 to the left grid of the control binary which is now above cutoff. This switches the control binary back to its original stable state, opening the gate to pass a trigger pulse to the second binary at count 8.

OUTPUT CIRCUITRY

As the DCU cycles through counts "1" to "10", ten discrete combinations of binary states are produced, corresponding to the binary code given in the table on the preceding page. The output voltage of binaries #2 through #4 is at one of two levels which we shall designate "high" or "low". The outputs are connected to the neon bulbs in a matrix using diodes so that if one lamp terminal is connected to a low potential the voltage at that point will remain low regardless of the output level of another binary which may be connected to the same terminal. The output voltage of binary #1 is either "low" or "intermediate" because the voltage divider networks in the plate circuits prevent the voltage from reaching the "high" level.

At count "1" lamp No. 1 has both high and low potentials existing at its terminals. The circuit can be analyzed as in Figure 5 for each count of the cycle in order to verify that this condition will exist for only one neon bulb at each count.

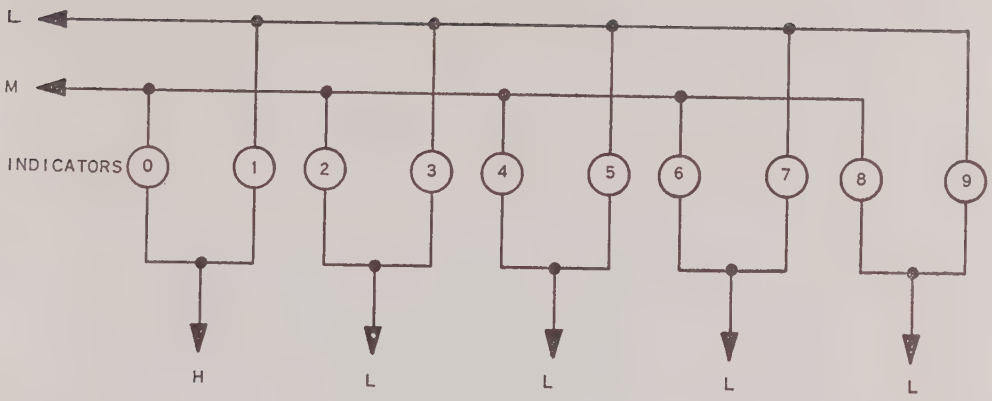


FIGURE 5.

VOLTAGE LEVELS ACROSS NEON BULBS EXISTING AT COUNT ONE (H = HIGH, M = INTERMEDIATE, L = LOW)

SERVICING

When a Decimal Counting Unit is suspected of counting incorrectly, it should be interchanged with a spare unit to determine whether the trouble is in the suspected unit or in the associated circuitry. This test should be made very carefully. Since the counting unit is usually the indicating device of a larger instrument, faulty operation is often ascribed to it when the symptoms of external faults are displayed.

TROUBLESHOOTING

Two methods are recommended for finding the trouble in a faulty counting unit. First, by observing the lighting sequence while driving the unit at a slow repetition rate, and second, by studying the waveform of each stage while driving the unit at a repetition rate fast enough to be conveniently viewed on an oscilloscope. It is impossible to say which method should be used in every case, since marginal failures may occur at high counting speeds and not at lower counting rates, and vice versa. The first method is the only way that a neon lamp failure can be located, and it can be used to locate component and tube failures. For this reason, it is recommended that this method be used first.

The Troubleshooting Chart (Table 3) lists some common troubles which may be readily localized by observing the lighting patterns. Figure 8 shows actual oscilloscope waveforms to be used for comparison. Voltage and resistance measurements at tube pins are given in Table 5.

It will be found that most failures are caused by faulty tubes.

TABLE 3

TROUBLESHOOTING CHART

NOTE: Reset unit before troubleshooting

Symptom	Cause
Unit fails to count	(a) Insufficient supply voltage
	(b) Input signal of insufficient amplitude
	(c) Input signal of wrong polarity
	(d) First stage inoperative
Unit counts spuriously	(a) Stray input signal
	(b) Pulses received through power supply
	(c) External voltages picked up by output lead
Unit counts erratically	(a) Input signal too large or small, incorrect rise time
	(b) Supply voltage fluctuating too much
Unit fails to reset	(a) Stray counts from reset switch or associated circuitry
	(b) Defective component

Symptom	Cause
Unit counts in wrong sequence	
1. Skips every other number	(a) First stage defective
	(b) Input circuit supplies double pulses
2. Skips 4 and 5	(a) 4th stage not being driven by the 3rd
3. Skips 6 and 7	(a) Defective gate diode (CR106)
Repeats a pattern of numbers	
1. Two stable states per cycle (0-1 or 2-3, etc.)	(a) 2nd stage not being driven
2. Four stable states per cycle (0-1-2-3 or 6-7-8-9)	(a) 3rd stage not being driven
3. Counts up to 5, then alternates between 4-5	(a) 4th stage not being driven by the 1st
Two lamps light simultaneously	Defective diode (CR101 to CR105)

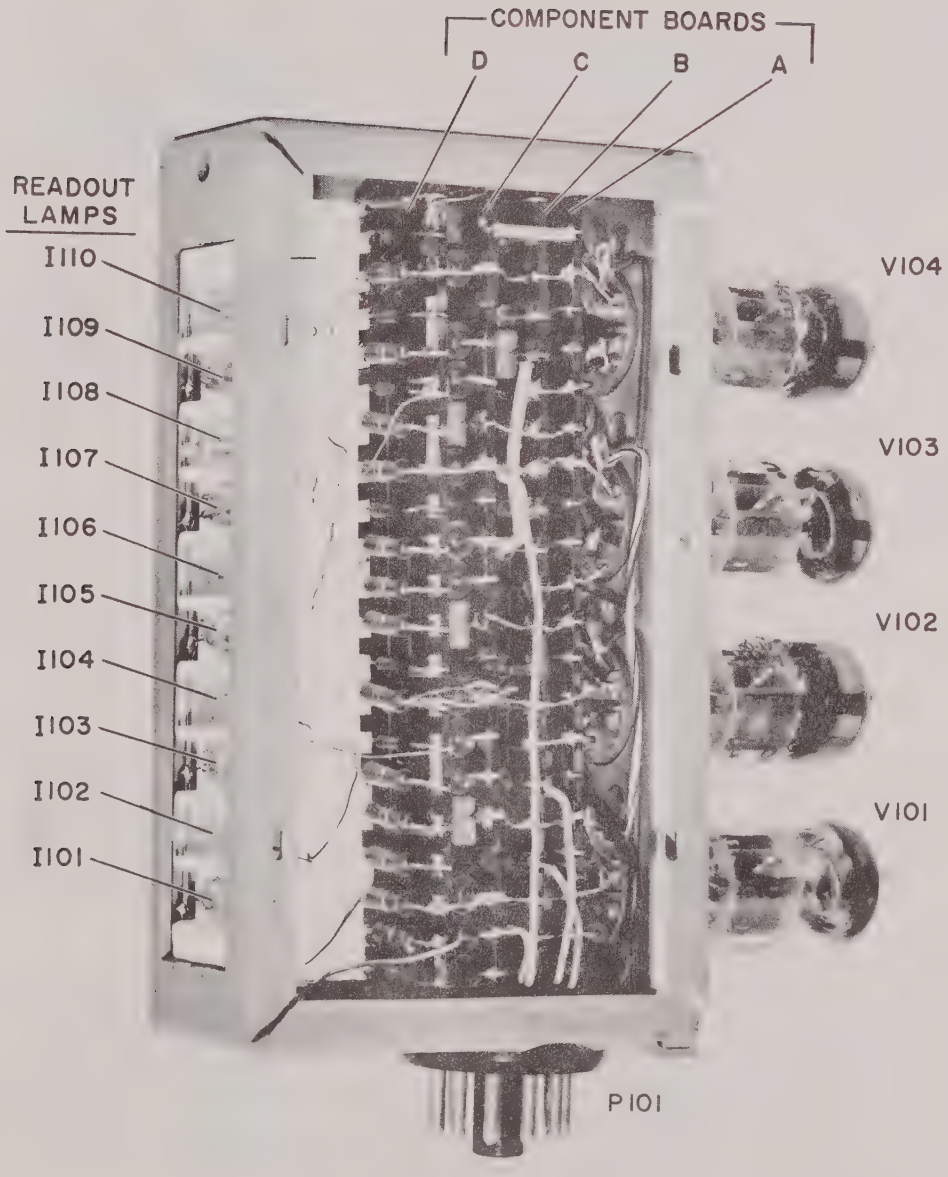


FIGURE 6.

MODEL 785A DCU WITH NUMBER MASK REMOVED

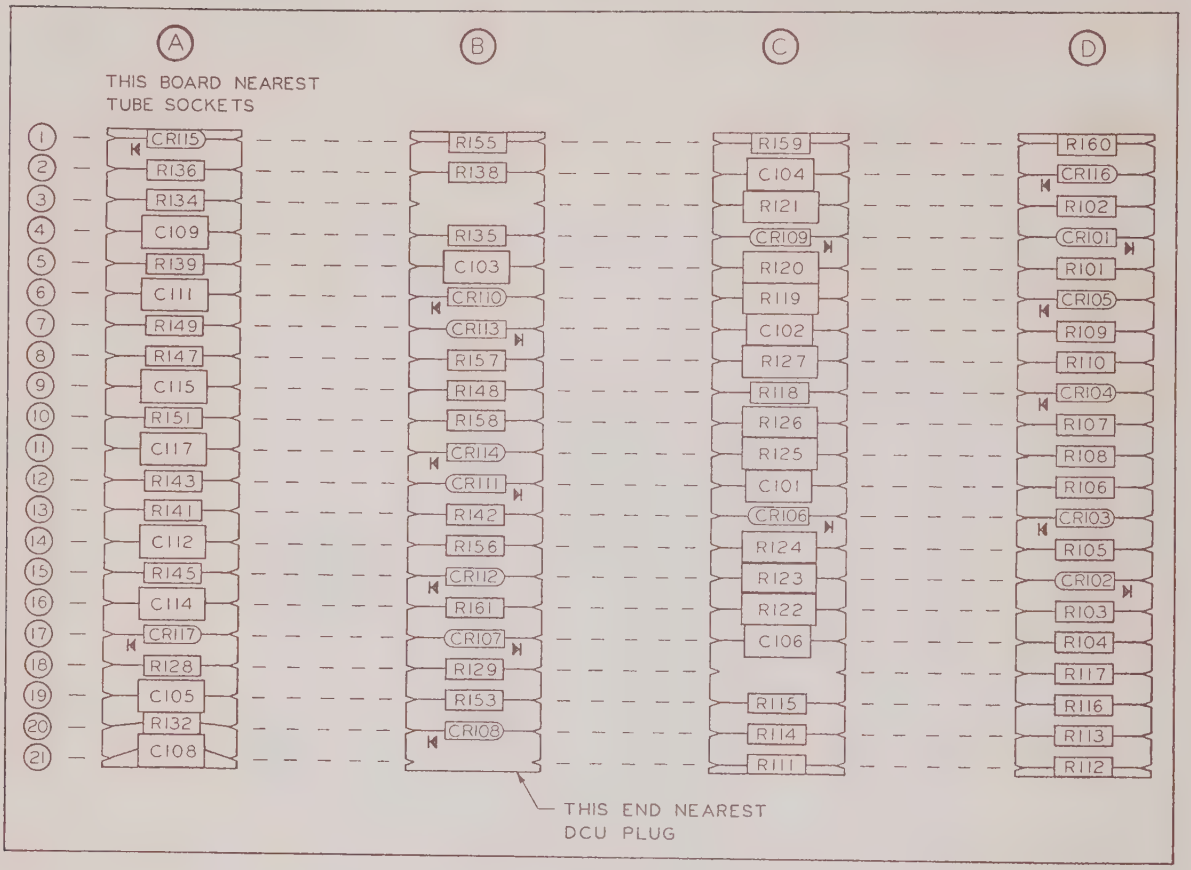


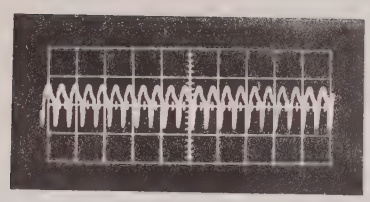
FIGURE 7.

COMPONENT BOARD LAYOUT

TABLE 4. PARTS LOCATION GUIDE*

Reference Number	Position (Fig. 7)	Reference Number	Position (Fig. 7)	Reference Number	Position (Fig. 7)
C101	C 12	CR115	A 1	R125	C 11
C102	C 7	CR116	D 2	R126	C 10
C103	B 5	CR117	A 17	R127	C 8
C104	C 2			R128	A 18
C105	A 19	R101	D 5	R129	B 18
C106	C 17	R102	D 3	R132	A 20
C108	A 21	R103	D 16	R134	A 3
C109	A 4	R104	D 17	R135	B 4
C111	A 6	R105	D 14	R136	A 2
C112	A 14	R106	D 12	R138	B 2
C114	A 16	R107	D 10	R139	A 5
C115	A 9	R108	D 11	R141	A 13
C117	A 11	R109	D 7	R142	B 13
		R110	D 8	R143	A 12
CR101	D 4	R111	C 21	R145	A 15
CR102	D 15	R112	D 21	R147	A 8
CR103	D 13	R113	D 20	R148	B 9
CR104	D 9	R114	C 20	R149	A 7
CR105	D 6	R115	C 19	R151	A 10
CR106	C 13	R116	D 19	R153	B 19
CR107	B 17	R117	D 18	R155	B 1
CR108	B 20	R118	C 9	R156	B 14
CR109	C 4	R119	C 6	R157	B 8
CR110	B 6	R120	C 5	R158	B 10
CR111	B 12	R121	C 3	R159	C 1
CR112	B 15	R122	C 16	R160	D 1
CR113	B 7	R123	C 15	R161	B 16
CR114	B 11	R124	C 14		

*Parts not listed in this table can be found at the appropriate tube socket terminals.

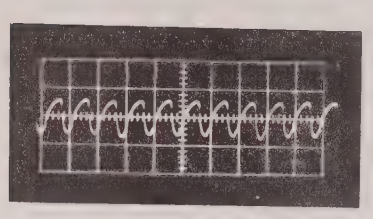


INPUT PULSES

Test Point: P101, pin 7

Vert. Scale: 5v/div

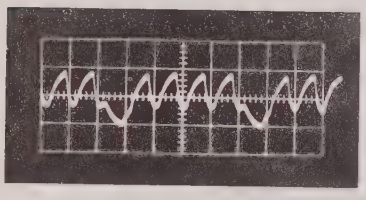
Note: The pulses shown are the output of a 10 mc DCU.



FIRST BINARY, PLATE B

Test Point: V101, pin 6

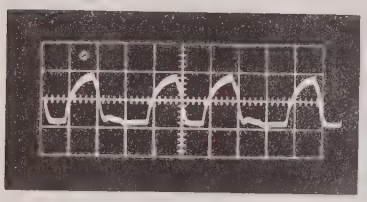
Vert. Scale: 50v/div



GATE DIODE (CR106), ANODE

Test Point: Junction CR106, C101, R118

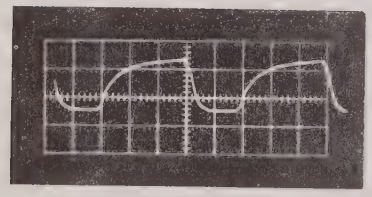
Vert. Scale: 50v/div



SECOND BINARY, PLATE B

Test Point: V102, pin 6

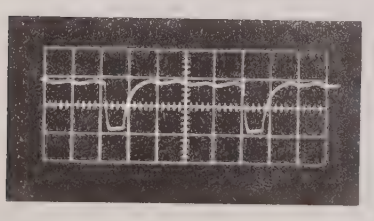
Vert. Scale: 50v/div



THIRD BINARY, PLATE B

Test Point: V103, pin 6

Vert. Scale: 50v/div



FOURTH (GATE CONTROL) BINARY, PLATE A

Test Point: V104, pin 1

Vert. Scale: 50 v/div

FIGURE 8

TYPICAL WAVEFORMS WITH INPUT FREQUENCY OF 1 MC.
TIME SCALE IS 2 μS/DIV

TABLE 5a

VOLTAGES

Note: Voltages measured to ground at count "0" with a vacuum tube voltmeter such as an RCA Volt-ohmyst Senior. B+ voltage is 200 volts.

Tube	Voltages at Tube Pin								
	1	2	3	4	5	6	7	8	9
V101	+170	+42	+56	0	0	+104	+56	+56	6.3AC
V102	+170	+38	+52	0	0	+94	+52	+52	6.3AC
V103	+170	+19	+32	0	0	+78	+33	+32	6.3AC
V104	+170	+37	+50	0	0	+92	+53	+50	6.3AC

TABLE 5b

RESISTANCES

Note: Resistances are measured to chassis ground with the DCU removed from its socket.

Tube	Resistances at Tube Pin								
	1	2	3	4	5	6	7	8	9
V101	23K	33K	7K	∞	∞	25K	26K	7K	∞
V102	26K	18K	5.8K	∞	∞	26K	15K	5.8K	∞
V103	25K	11K	3.4K	∞	∞	24K	11K	3.4K	∞
V104	26K	21K	6K	∞	∞	26K	17K	6K	∞

PARTS LIST

MODEL 785A DECIMAL COUNTING UNIT

Refer to Dwg. No. D 402889

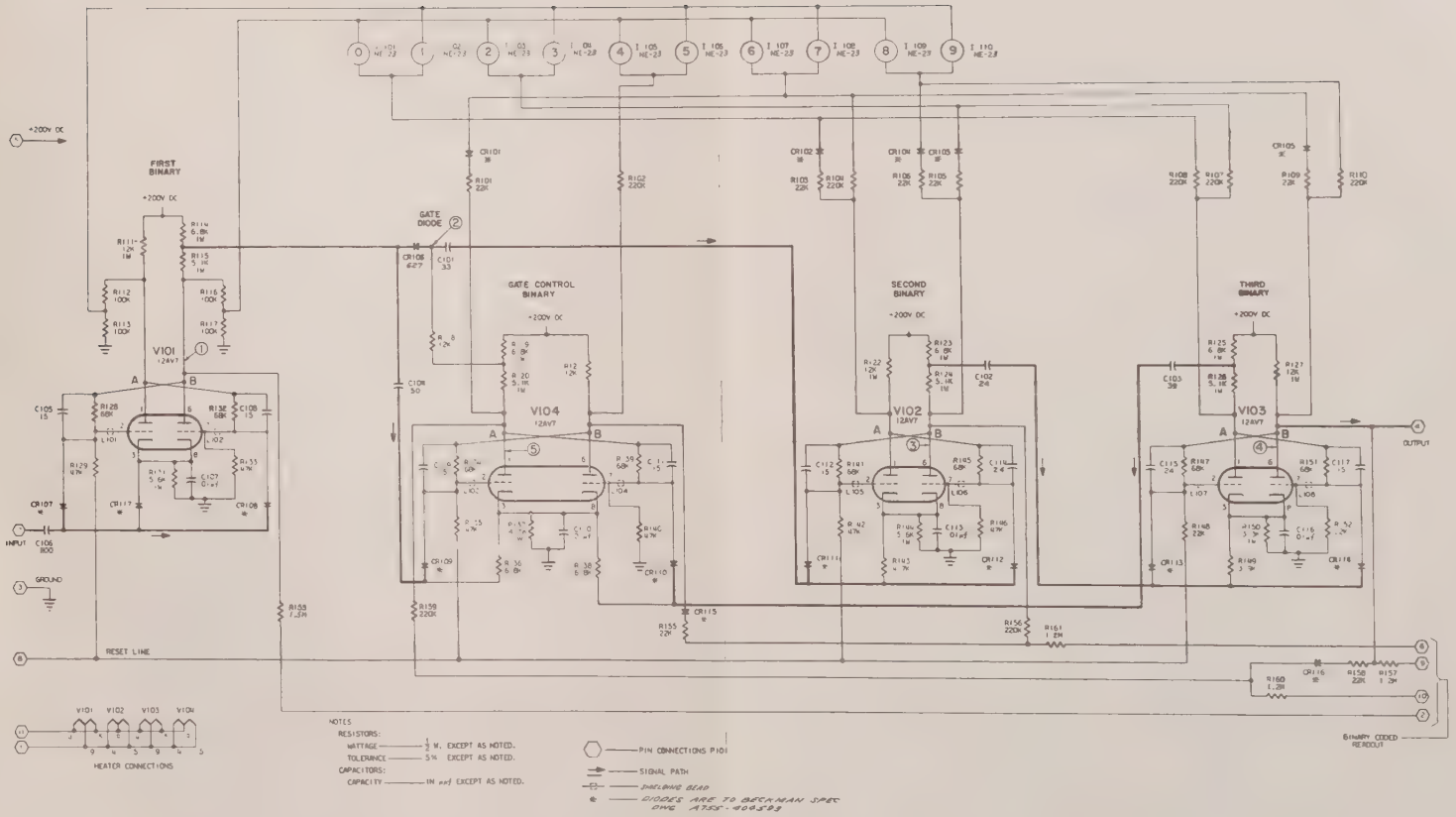
NOTE

The following parts list includes all electrical components except fixed composition resistors whose value, rating, and tolerance are given on the schematic diagram.

Detail No.	Berkeley Stock No.	Description	Manufacturer & No.
C101	2-2607	Capacitor, mica, 33μμf, 500V, 5%	Sangamo RR1433
C102	2-2554	Capacitor, mica, 24μμf, 500V, 5%	Sangamo DR1424
C103	2-3157	Capacitor, mica, 39μμf, 500V, 5%	Sangamo RR1439
C104	2-2141	Capacitor, mica, 50μμf, 500V, 5%	Sangamo RR1450
C105	2-2135	Capacitor, mica, 15μμf, 500V, 5%	Sangamo RR1415
C106	2-2137	Capacitor, mica, 500μμf, 300V, 5%	Sangamo RR1350
C107	2-4388	Capacitor, ceramic, .01μf, 500V, +80 -20%	Sprague 29C9
C108 & C109		Same as C105	
C110		Same as C107	
C111 & C112		Same as C105	
C113		Same as C107	
C114		Same as C105	
C115		Same as C102	
C116		Same as C107	
C117		Same as C105	
CR101 thru CR105	404593	Diode, Same as CR101	Beckman/Berkeley
CR106	8-7453	Diode, 1N627	
CR107		Same as CR101	
CR108 thru CR114		Same as CR107	
CR115 & CR116		Same as CR101	
CR117		Same as CR107	
I101	21-6180	Lamp, NE23	General Electric
I102 thru I110		Same as I101	
L101	3-7251	Ferrite bead	Ferroxcube 255 T 118 A 205
L102 thru L108		Same as L101	
P101	17-1719	Plug, 11 pin	Amphenol 86CP11
V101	5-5977	Tube, 12AV7	
V102 thru V104		Same as V101	
XV101	4-3317	Socket, 9 pin	Elco 280BC
XV102 thru XV104		Same as XV101	

February 1962

MODEL 785A DECIMAL COUNTING UNIT
SCHEMATIC DIAGRAM



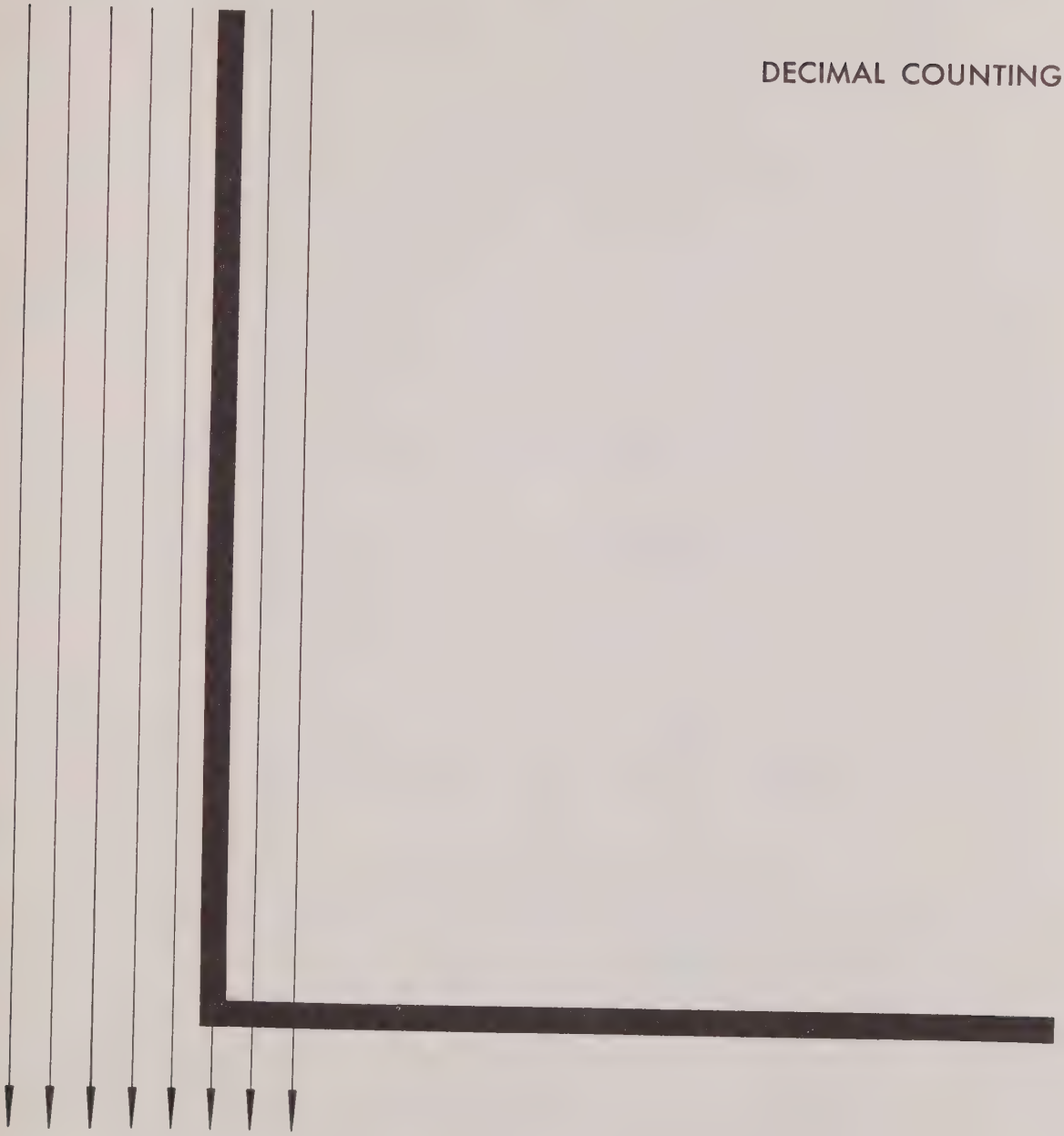
Beckman

TABLE 5a

INSTRUCTION MANUAL

Models 775, 775AJ
& 775K

DECIMAL COUNTING UNITS



Beckman® INSTRUMENTS, INC.

BERKELEY DIVISION
2200 Wright Avenue
Richmond, California

1960

WARRANTY

Instruments sold by Berkeley Division, Beckman Instruments, Inc., (hereafter called "the Company") are warranted only as stated below.

Subject to the exceptions and upon the conditions specified below, the Company agrees to correct, either by repair, or, at its election, by replacement, any defect of material or workmanship which develops within one year after delivery of the instrument to the original purchaser by the Company or by an authorized representative, provided that investigation and factory inspection by the Company discloses that such defect developed under normal and proper use.

The exceptions and conditions mentioned above are the following:

(a) Some components and accessories by their nature are not intended to, and will not, function one year. If any such component or accessory manufactured by the Company and part of the item sold fails to give reasonable service for a reasonable period of time, the Company will, at its election, replace or repair such component or accessory. What constitutes reasonable service and what constitutes a reasonable period of time shall be determined solely by the Company after the Company is in posession of all the facts concerning operating conditions and other pertinent factors and after such component or accessory has been returned to the Company, transportation prepaid.

(b) All instruments claimed defective must be returned to the Company, transportation charges prepaid, and will be returned to the customer with the transportation charges collect, unless the item is found to be defective in which case the Company will pay all transportation charges.

(c) The Company makes no warranty concerning components or accessories not manufactured by it, such as tubes, fuses, batteries, etc. However, in the event of the failure of any component or accessory not manufactured by the Company, the Company will give reasonable assistance to the purchaser in obtaining from the respective manufacturer whatever adjustment is reasonable in the light of the manufacturer's own warranty.

(d) Except as stated above, the Company makes no warranty, express or implied (either in fact or by operation of law), statutory or otherwise; and, except to the extent stated above, the Company shall have no liability under any warranty, express or implied (either in fact or by operation of law), statutory or otherwise.

(e) The Company expressly disclaims any liability to its customers, dealers, and to users of its products, and to any other person or persons for consequential damages of any kind and from any cause whatsoever arising out of or in any way connected with the manufacture, sale, repair, replacement of, or arising out of or in any way connected with the use of any of its products.

(f) Representations and warranties made by any person, including representatives of the Company, which are inconsistent or in conflict with the terms of this warranty (including but not limited to the limitation of the liability of the Company as set forth above) shall not be binding upon the Company unless reduced to writing and approved by an officer of the Company.

(g) This warranty shall be governed by the laws of the State of California.

Claims for damage in shipment should be filed promptly with the transportation company.

All correspondence concerning the instrument should specify the model and serial number. This information appears on the company name plate. Any inquiry concerning details of operation, possible modifications, etc., should be addressed to the Sales Department, Berkeley division of Beckman Instruments, Inc., Richmond 4, California.

REPAIR SERVICE

Experienced service personnel and special test equipment are available at the factory to perform any necessary repairs. Every effort will be made to expedite the repair of instruments returned for servicing. Repair work will be performed only upon receipt of a written purchase order or authorization. Instruments to be repaired should be addressed to SERVICE AND REPAIR DEPARTMENT with transportation charges prepaid. Repaired instruments will be returned to the purchaser with transportation charges collect.

Berkeley reserves the right to make changes in design at any time without incurring any obligation to modify equipment previously purchased to conform to subsequent design changes.

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Appendix

Model 775R,
Dwg. No. C 402830

INTRODUCTION

These decimal counting units are direct-reading, plug-in electronic counters. The number of input pulses received is indicated by the illumination of one of ten neon lamps placed behind a numbered acetate panel. Each unit counts from zero to nine, the tenth pulse resetting the counter to zero and simultaneously generating an output signal. Any number of these units can be connected in cascade (the output of one unit driving the next) forming a counter whose total count capacity depends only on the number of DCU's. Thus, five units will count to 99,999 resetting to "00,000" on the 100,000th pulse.

Models 775 and 775K generate a binary coded decimal readout. This code is in the form of high or low voltages at each of four pins on the DCU plug.

SPECIFICATIONS

Count Indication

Direct reading, decimal presentation

Power Requirements

Heaters: 6.3 v. at 1.2 amps
Plates: 300 v. at 13 ma

Input Requirements

Negative pulses (see "OPERATION")

Output Characteristics

Designed to drive a Model 775 DCU or any modification except a 775LJ (i.e., 775AJ, 775K, etc.).

Resolution of Paired Pulses

5 microseconds

Reset

Will reset to either zero or nine depending on polarity of reset pulse applied.

Maximum Counting Rate

120,000 counts per second

Construction

Plug-in unit, 11-pin socket

OPERATION

Power Requirements. The heaters require 6.3 volts a-c at 1.2 amperes. The plate circuits may be operated on from 200 to 400 volts, although the design center is 300 volts at 13 ma. Plate voltage may be applied in the form of B + and B - voltages. The d-c level of all output voltages will depend upon the level of the plate supply voltages.

Input Requirements. A negative pulse at least two microseconds wide is required to drive the unit. The optimum pulse amplitude depends on the rise time. With a rise time of 0.5 microseconds (measured between ten and ninety percent values) the pulse amplitude should be between 75 and 135 volts. With a two-microsecond rise time, the amplitude should be between 120 and 165 volts. When operating the plate circuits on 300 volts, optimum performance is obtained with a rise time of one microsecond or less and a pulse amplitude of 100 volts. If the unit is powered by unregulated d-c supplies, the input pulse amplitude should vary in phase with the supply voltage. The input load presented when an input pulse occurs is 15K ohms in series with 100 picofarads ($\mu\mu$f).

Output Characteristics. The output is the rectangular waveform shown in Figure 3. As every tenth input pulse triggers the unit from count display "9" to count display "0", a negative transient occurs at pin 4 of the DCU plug. With a plate supply of 300 volts, the potential at pin 4 drops from +135 to +55 volts with respect to B-. This transient can be used to drive succeeding decimal counting units or other circuitry. The load impedance connected

between the output terminal and ground must not be less than 300K or 6K in series with 100 picofarads.

Method of Resetting after a Counting Period. A DCU can be reset to a registered count of either zero or nine by the application of a voltage pulse of the proper polarity to the proper pin of the DCU plug. See the table below.

	RESET TO ZERO		RESET TO NINE	
	Pulse Polarity	Applied at Pin No.	Pulse Polarity	Applied at Pin No.
775	Neg.	8	Pos.	8
775AJ	Neg.	8	Pos.	8
	Pos.	3	Neg.	3
775K	Neg.	8	Pos.	8

The reset pin (or pins in the base of Model 775AJ) should be maintained at the B- supply voltage except when a reset pulse occurs. A 50-volt pulse at least 3μseconds wide is adequate. A 100-volt pulse need be only 1.5μseconds wide. There is no maximum pulse width; however the DCU will not begin counting again until the reset pin returns to the B- supply voltage.

Simply disconnecting a reset pin from B- with a switch or relay will have the same effect as applying a positive pulse.

Binary Code Readout. Models 775 and 775K generate a modified binary code representing the decimal digit registered. The code appears in the form of a voltage (high or low) at one plate of each of four double-triode binaries. In the table below, "0" represents a plate voltage of approximately +55 volts with respect to B-; "1" represents a plate voltage of about +135 volts with respect to B-. (These are the voltage levels which appear when using a 300-volt plate supply.) Each of the four plates is coupled to a pin of the DCU plug through a 1.2 megohm resistor except in the case of pin 4 on the 775K DCU. This pin is connected directly to a plate of the fourth binary. To obtain a readout voltage at this pin, it is necessary to add a 1.2M resistor externally.

DECIMAL DIGIT REGISTERED	FOUR - LINE BINARY CODE			
	1st Binary Stage	2nd Binary Stage	3rd Binary Stage	4th Binary
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	1	1	0
5	1	1	1	0
6	0	0	1	1
7	1	0	1	1
8	0	1	1	1
9	1	1	1	1

Extinguishing the Indicating Lamps During the Counting Period. On Models 775 and 775K, it is possible to prevent the neon lamps from lighting by placing approximately +100 volts with respect to B- on pin 10 of the DCU plug. Ordinarily, the user will wish to extinguish the lamps while the DCU is actively counting, and to allow them to light, indicating the registered count, at the end of a counting period.

CIRCUIT DESCRIPTION

The Binaries. The decimal counting units contain four "flip-flop" circuits. These circuits are slightly modified versions of the Eccles-Jordan trigger circuit. They are referred to here as binaries.

Figure 1 is a schematic diagram of a typical binary. It consists of two triode voltage amplifiers with the plate of each direct-coupled to the grid of the other. With no input this circuit assumes one of two stable states: V1 conducting steadily and V2 cut

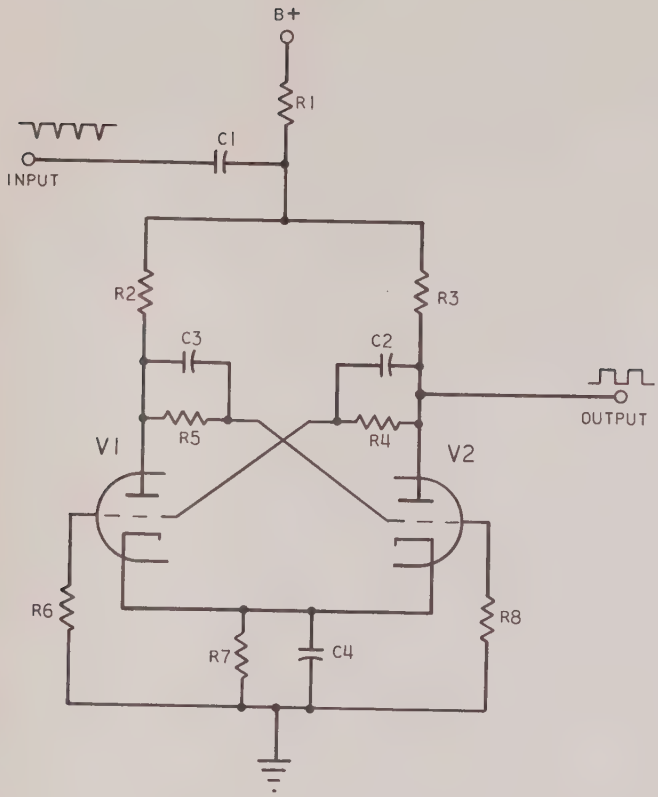


FIGURE 1. A TYPICAL BINARY.

off, or V2 conducting and V1 cut off. Suppose V1 is not conducting. Then, its plate is near the B+ voltage. A portion of this voltage, applied to the grid of V2 through the voltage dividing network R5 and R8, raises this grid above cut-off and permits V2 to conduct. While V2 is conducting, the low positive potential at its plate, coupled to the grid of V1 through the dividing network R4 and R6, holds this grid several volts below cut-off. Since small changes in the potential at the grid of V1 will not raise it above cut-off, this state is stable and will persist until disturbed by an appreciable input signal. Notice that, since the circuit is symmetrical, the opposite state is equally stable.

The circuit is triggered from one state to another by negative pulses applied at the input. For example, assume that V2 is conducting and V1 is cut off. If a negative pulse is applied to the input, there is a drop in the plate voltage of V1. This drop in voltage is transmitted through a crossover network (R5, R8, C3 and the grid-to-ground capacitance of V2) and applied to the grid of V2. The plate voltage of V2 then starts to rise, carrying with it the grid of V1. If the input pulse is of sufficient amplitude, V1 begins to conduct. The moment V1 conducts, the drop in voltage at its plate, coupled to the grid of V1, reinforces the negative transient there. This regenerative action proceeds rapidly until V2 is cut off and V1 is conducting at a steady rate. The next adequate input transient causes a reverse action and returns the binary to its original state. Thus, the binary completes a cycle for every two input transients applied, making it a scale-of-two. The output is the drop in voltage at one of the plates as that triode begins to conduct. This output, consisting of one negative transient for every two input transients, is suitable for driving another binary. By connecting binaries in cascade (output of one to input of the next) a counter having a scale of any power of two can be built.

The Scale of Ten. In the Model 775 four binaries are connected in cascade forming a scale-of-16 which is permuted to a scale-of-10 by two positive feedback paths. (See Figures 2 and 3). For the first three negative input pulses, the unit operates like a simple binary counter. At the fourth input pulse, the third binary is triggered for the first time, sending a pulse through the first feedback path which triggers the second binary. Since it requires two input pulses to trigger the second binary, this is equivalent to adding two input pulses; therefore, the state of the unit now

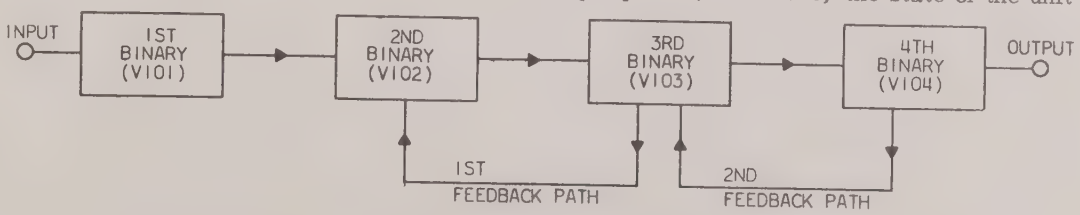


FIGURE 2. BLOCK DIAGRAM.

corresponds to a binary count of six. The sixth input pulse (equivalent to the eight in a simple binary chain) triggers the fourth binary which sends a pulse through the second feedback path, triggering the third binary. This is equivalent to adding four more input pulses so the state of the unit now corresponds to a binary count of 12. For the next four input pulses (7 thru 10) the unit operates again as a simple binary chain, producing an output pulse at the tenth input pulse. Adding the equivalent of six input pulses internally has changed the binary chain from a scale-of-16 to a scale-of-10.

When the third binary is triggered by a feedback pulse, it tends to retrigger the second binary in the same way that it did at the time of input pulse four. This tendency is offset by a simultaneous opposing signal from the fourth binary.

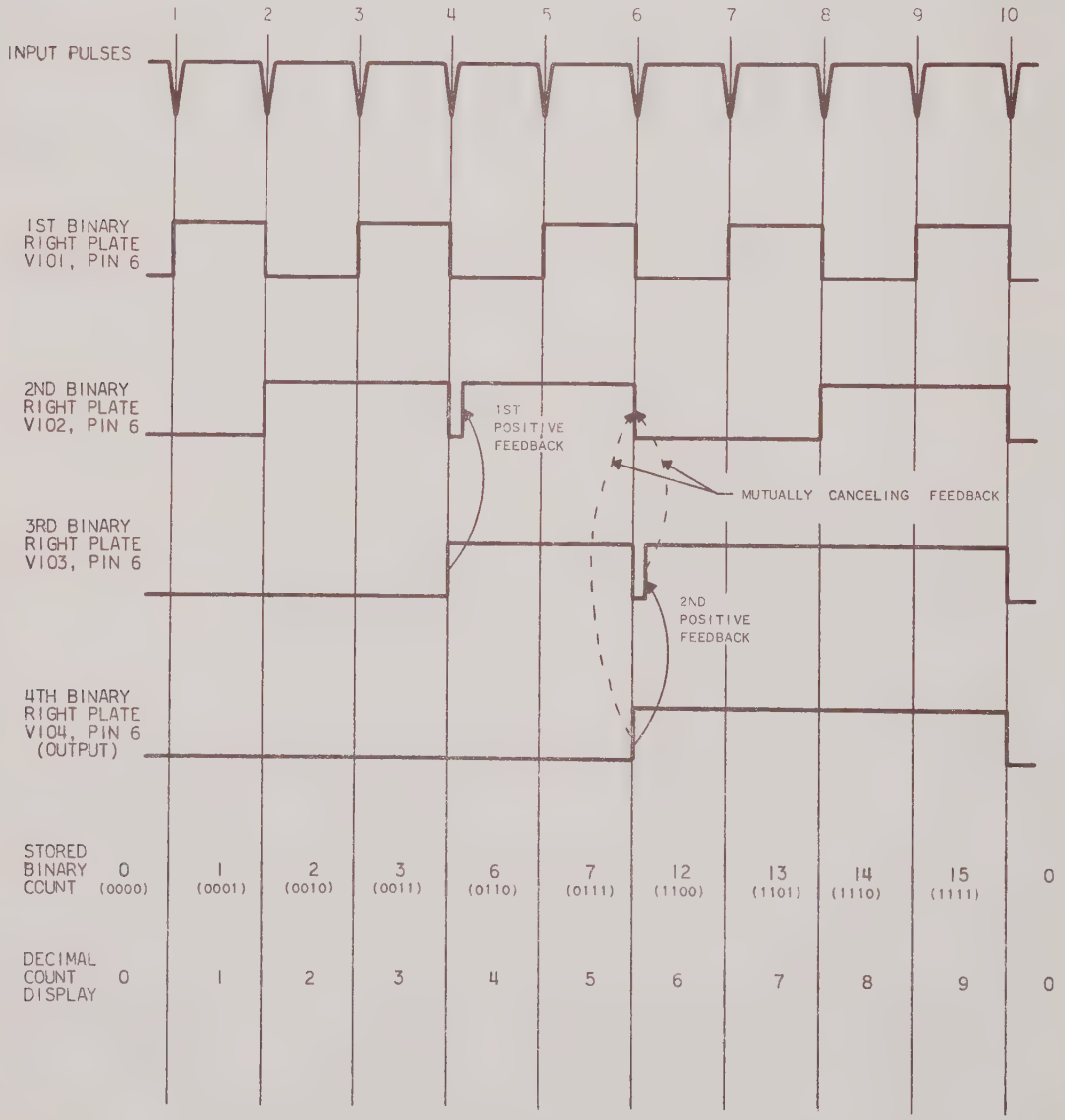


FIGURE 3. IDEALIZED WAVEFORMS. "RIGHT PLATE" REFERS TO THE PLATE APPEARING ON THE RIGHT-HAND SIDE OF THE BINARY AS DRAWN ON THE SCHEMATIC.

TROUBLESHOOTING PROCEDURES

When a decimal counting unit is suspected of counting incorrectly, it should be interchanged with another unit in the instrument or replaced with a spare unit to determine whether the trouble is in the suspected unit or in the associated circuitry. This test should be made very carefully. Because the counting unit is usually the indicating device of an instrument, it is often accused of operating incorrectly when the fault is external to it.

Two methods are recommended for locating a defect in a DCU. The first is to observe the lighting sequence while driving the unit at a slow pulse rate. The second is to study the output waveform of each binary while driving the unit fast enough to create an oscilloscope display. It is impossible to say which method should be used in every case, since marginal failures may occur at high counting speeds and not at lower counting rates, and vice versa. The first method is the only way that a neon lamp failure can be located, and it can be used to locate component and tube failures. For this reason, it is recommended that this method be used first. The table of common troubles lists the probable defects indicated by particular variations from the proper lighting sequence. Binary output waveforms may be compared with the idealized waveforms of Figure 3 and the photographs appearing in Figure 4 & 5.

A table of typical voltages and resistances has been provided to help the serviceman locate a defect within one of the binary stages. Values may deviate considerably from those given without causing trouble. The fact that the unit is designed to operate at plate supply voltages ranging from 200 to 400 volts is a rough indication of permissable tolerances.

TROUBLESHOOTING CHART

NOTE: Reset unit to zero before testing for symptoms

SYMPTOMS	POSSIBLE CAUSES
Unit Fails to Count	(a) Insufficient supply voltage. (b) Input signal of insufficient amplitude (c) Input signal of wrong polarity. (d) First stage inoperative.
Unit Counts Spuriously	(a) Extraneous input signals. (b) Pulses received through power supply. (c) External voltages picked up by output lead.
Unit Counts Erratically	(a) Input signal too large or small, incorrect rise time. (b) Supply voltage fluctuating too much.
Unit Fails to Reset	(a) Stray counts from reset switch or associated circuitry. (b) Defective component.

Unit counts regularly but neon bulbs light in wrong sequence and the pattern of lighting is repeated consistently after a definite number of input pulses. One or more bulbs may be lit simultaneously during a cycle but the number of states per cycle remains constant.

1. Unit skips every other number	(a) First stage defective. (b) Input circuit supplies double pulses.
2. Two stable states per cycle.	(a) Second stage defective (Display sequence may be 01 or 45). (b) Loss of drive to second stage (01).
3. Four stable states per cycle.	(a) Third stage defective (Display sequence may be 0123 or 6789). (b) Loss of drive to third stage (0123).
4. Six stable states per cycle.	(a) Output excessively loaded (Display sequence may be 012345). (b) Last stage inoperative (Display sequence may be 1 012345 or $67^{89}_{23}89$*). (c) Loss of drive to fourth stage (Display sequence may be 012345).
5. Eight stable states per cycle or any failure where two successive numbers are skipped.	(a) Second or third stage failure.
6. Ten stable states per cycle, but the lighting sequence is incorrect.	(a) When the wrong neon lamp lights, the trouble is usually a defect in the lamp that should have lit, but it may be a defect in the lamp that lit improperly. It's also possible that more than one lamp will light in place of the correct one.
7. Twelve stable states per cycle.	(a) When lighting sequence is $0123^{01}_{45}456789$* the cause may be a failure of the first feedback or lowered cathode emission in first or second binary. (b) When the lighting sequence is $01234567^{23}_{89}89$ the cause may be failure of the second feedback or low cathode emission in third or fourth binary.

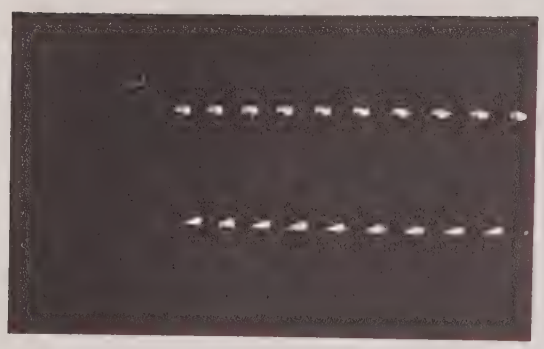
* One digit above another means both lamps are lit.

TABLE OF VOLTAGES & RESISTANCES

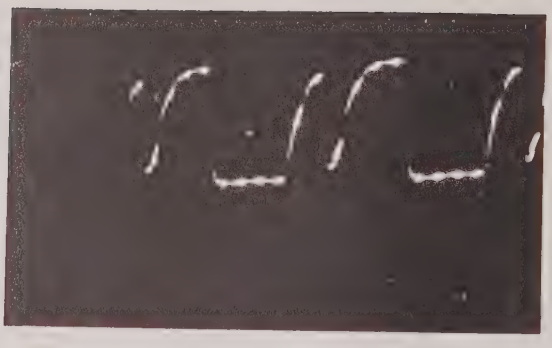
Tube	Pin No.	D-C Voltage with respect to B-.*	Resistance to B minus Terminal**
V101	1	170	105K
	2	17	85K
	3, 8	37	12K
	4, 5, 9	Filaments	
	6	60	105K
	7	37	85K
V102	1	135	93K
	2	15	83K
	3, 8	30	12K
	4, 5, 9	Filaments	
	6	55	93K
	7	30	83K
V103	1	135	100K
	2	15	83K
	3, 8	30	12K
	4, 5, 9	Filaments	
	6	55	100K
	7	30	83K
V104	1	135	93K
	2	15	83K
	3, 8	30	12K
	4, 5, 9	Filaments	
	6	55	93K
	7	30	83K

* Voltages measured in unit with 300-volt plate supply

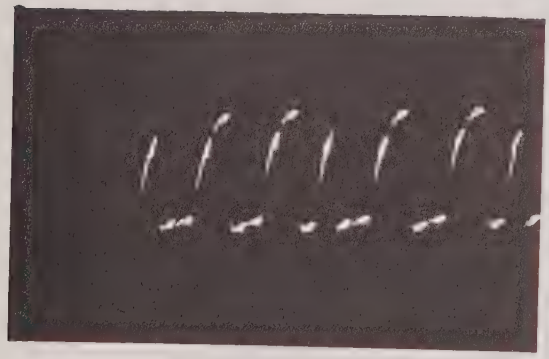
** Before making resistance measurements jumper pins 3 and 8 on the DCU plug.



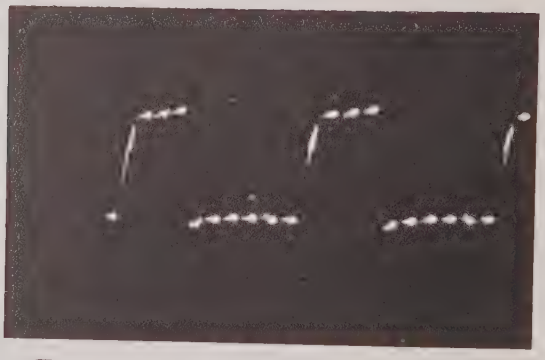
(1) First Binary Output (V101, Pin 6).
Upper voltage level is +168v
Lower voltage level is +55v



(2) Second Binary Output (V102, Pin 6)
Upper voltage level is +140v
Lower voltage level is +55v.

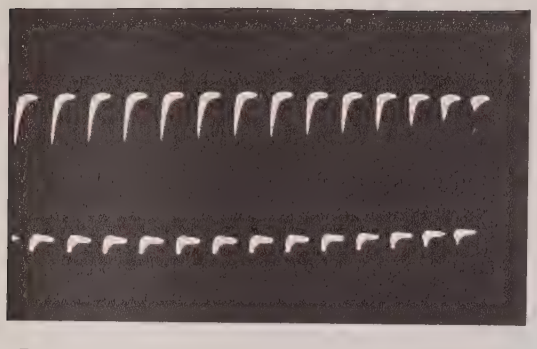


(3) Third Binary Output (V103, Pin 6)
Upper voltage level is +140v.
Lower voltage level is +55v.

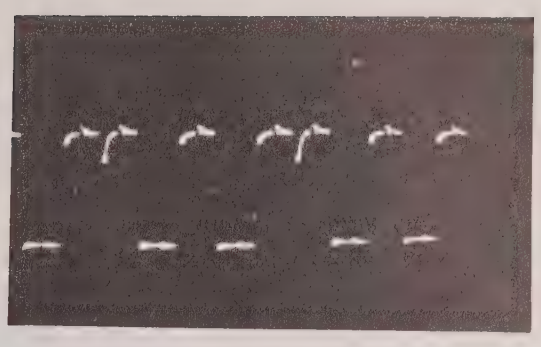


(4) Fourth Binary Output (V104, Pin 6).
Upper voltage level is +140v.
Lower voltage level is +55v.

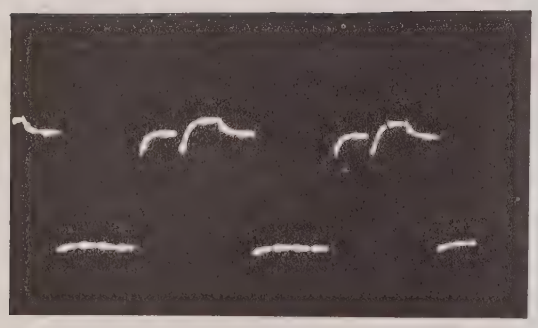
FIGURE 4. BLANKED WAVEFORMS AT INPUT FREQUENCY OF 100KC. ALL VOLTAGE LEVELS ARE MEASURED WITH RESPECT TO B MINUS.



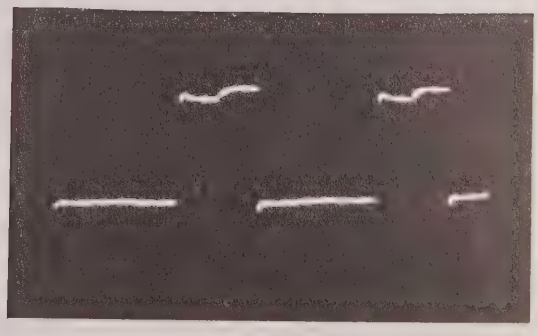
(1) First Binary Output (V101, Pin 6).
Upper Voltage level is +168V
Lower voltage level is +55v



(2) Second Binary Output (V102, Pin 6)
Upper voltage level is +140v
Lower voltage level is +55v.



(3) Third Binary Output (V103, Pin 6)
Upper voltage level is +140v.
Lower voltage level is +55v



(4) Fourth Binary Output (V104, Pin 6).
Upper voltage level is +140v.
Lower voltage level is +55v.

FIGURE 5. BLANKED WAVEFORMS AT INPUT FREQUENCY OF 20KC. ALL VOLTAGE LEVELS ARE MEASURED WITH RESPECT TO B MINUS.

COMPONENT LOCATION GUIDE

REFERENCE NO.	COMPONENT BOARD LOCATION		
	MODEL 775 FIG. 7	MODEL 775 AJ FIG. 9	MODEL 775 K FIG. 11
C101	B 17	B 17	B 17
C102	B 18	B 18	B 18
C103	C 12	C 12	C 12
C104	C 7	C 7	C 7
C105	A 19	A 19	A 19
C106	A 21	A 21	A 21
C107	A 13	A 13	A 13
C108	A 15	A 15	A 15
C109	A 8	A 8	A 8
C110	A 10	A 10	A 10
C111	A 3	A 3	A 3
C112	A 5	A 5	A 5
C113*	A 17	A 17	A 17
C114*	A 12	A 12	A 12
C115*	A 7	A 7	A 7
C116*	A 2	A 2	A 2
C117	B 8	B 8	B 8
C118	C 6	C 6	C 6
C119	B 12	B 12	B 12
C120	-	D 2	-
CR101	-	D 20	D 20
CR102	-	D 18	D 19
R101	D 21	D 21	D 21
R102	D 17	D 17	D 17
R103	D 16	D 16	D 16
R104	D 15	D 15	D 15
R105	D 14	D 14	D 14
R106	D 13	D 13	D 13
R107	D 11	D 11	D 11
R108	D 8	D 8	D 8
R109	D 6	D 6	D 6
R110	D 5	D 5	D 5
R111	D 4	D 4	D 4
R112	D 3	D 3	D 3
R113	C 19	C 19	C 19
R114	C 14	C 14	C 14
R115	C 9	C 9	C 9
R116	C 4	C 4	C 4
R117	C 20	C 20	C 20
R118	C 17	C 17	C 17
R119	C 21	C 21	C 21
R120	C 18	C 18	C 18
R121	C 16	C 16	C 16
R122	C 13	C 13	C 13
R123	C 11	C 11	C 11
R124	C 8	C 8	C 8
R125	C 5	C 5	C 5
R126	C 3	C 3	C 3
R127	A 18	A 18	A 18
R128	A 20	A 20	A 20
R129	A 14	A 14	A 14
R130	A 16	A 16	A 16
R131	A 9	A 9	A 9
R132	A 11	A 11	A 11
R133	A 4	A 4	A 4
R134	A 6	A 6	A 6
R135	B 19	B 19	B 19
R136	B 20	B 20	B 20
R137	B 14	B 14	B 14
R138	B 15	B 15	B 15
R139	B 9	B 9	B 9
R140	B 10	B 10	B 10
R141	B 4	B 4	B 4
R142	B 5	B 5	B 5
R143	A 17	A 17	A 17
R144	A 12	A 12	A 12
R145	A 7	A 7	A 7
R146	A 2	A 2	A 2
R147	B 13	B 13	B 13
R148	C 10	C 10	C 10
R149	D 2	-	-
R150	D 7	-	D 7
R151	D 12	-	D 12
R152	D 18	-	D 18
R162	B 6	B 6	B 6
R163	-	D 9	-
R164	-	D 19	-

*Reverse side of board

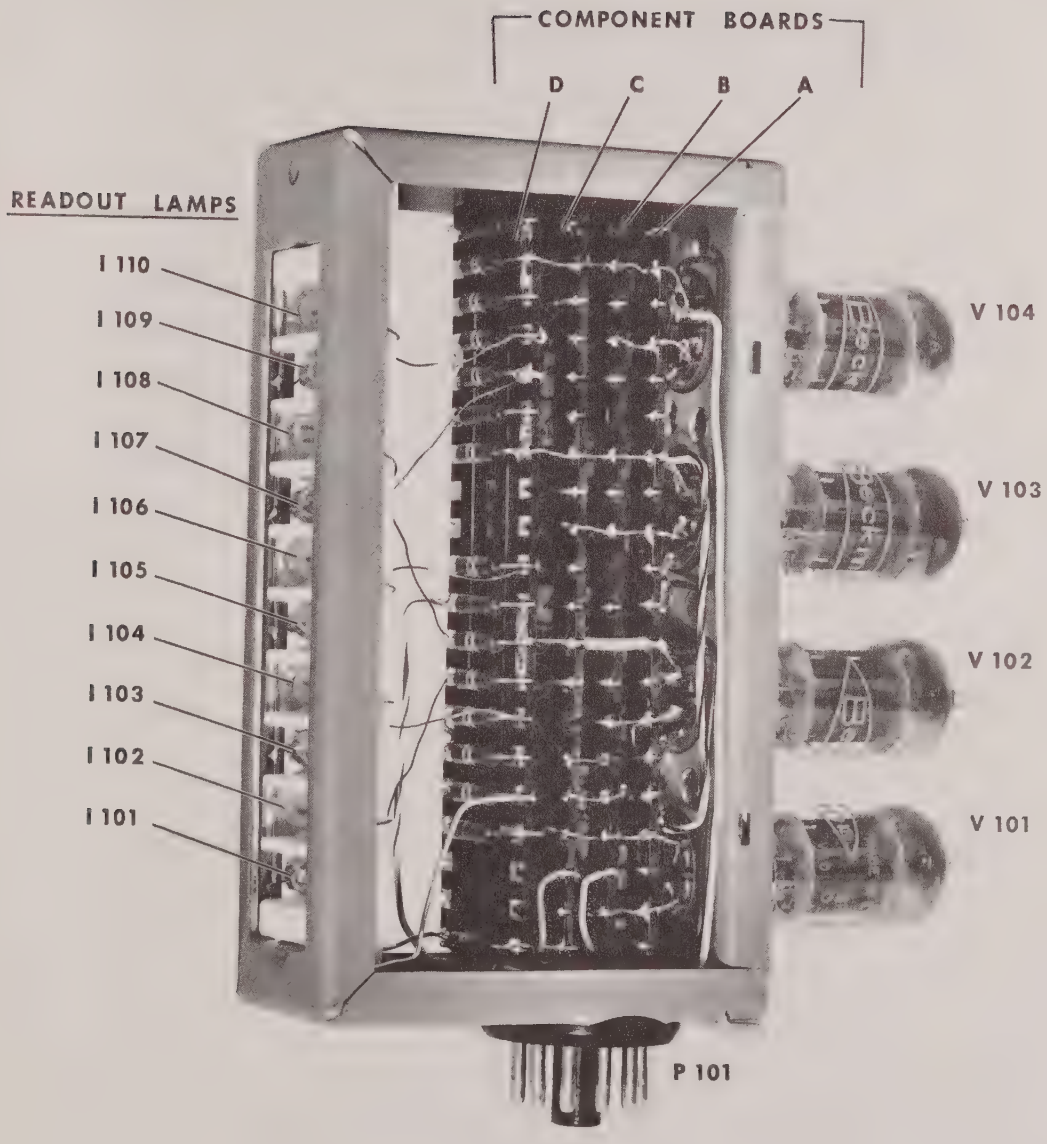


FIGURE 6. MODEL 775 DCU WITH NUMBER MASK REMOVED.

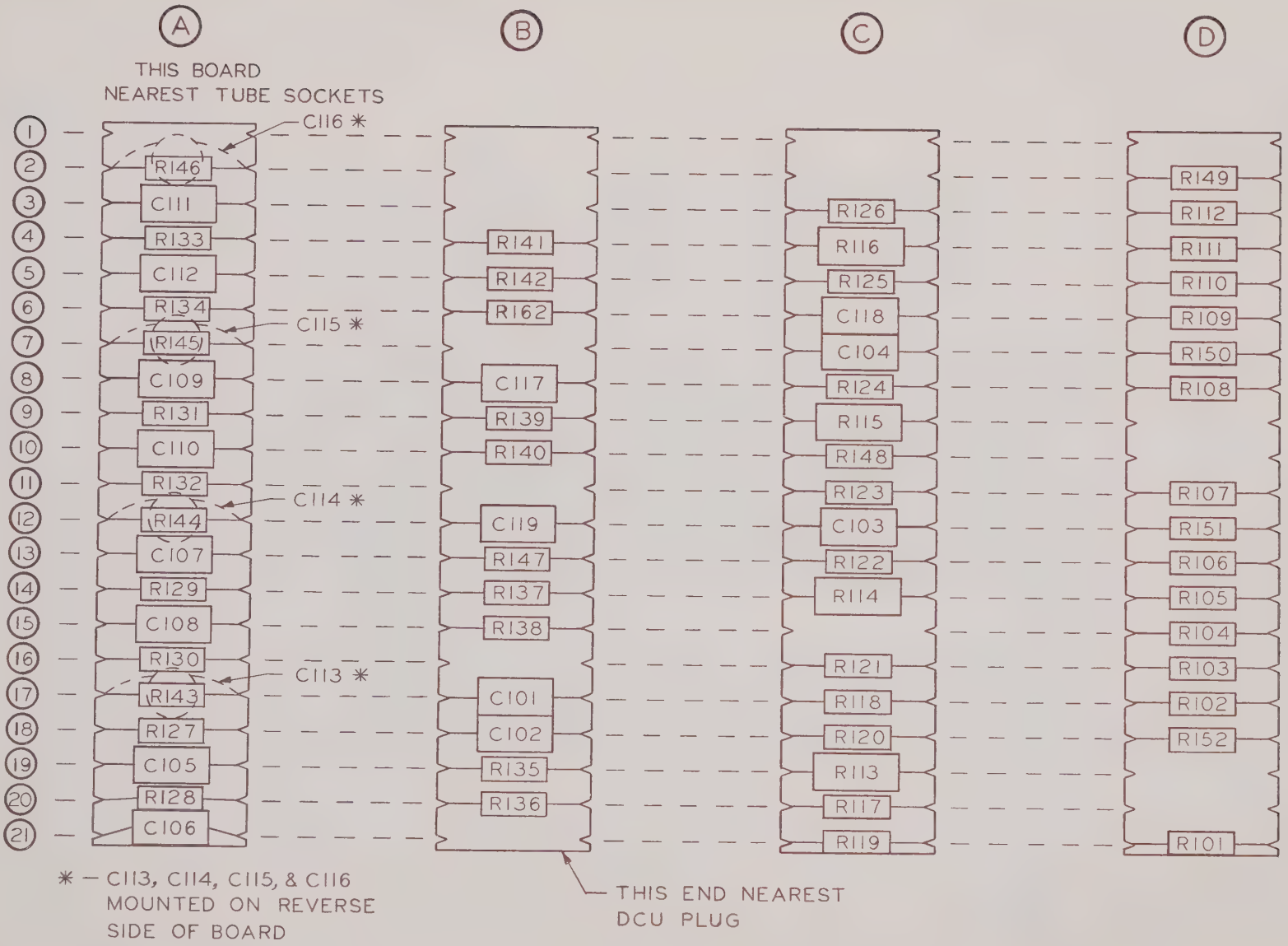


FIGURE 7. MODEL 775 COMPONENT BOARD LAYOUT.

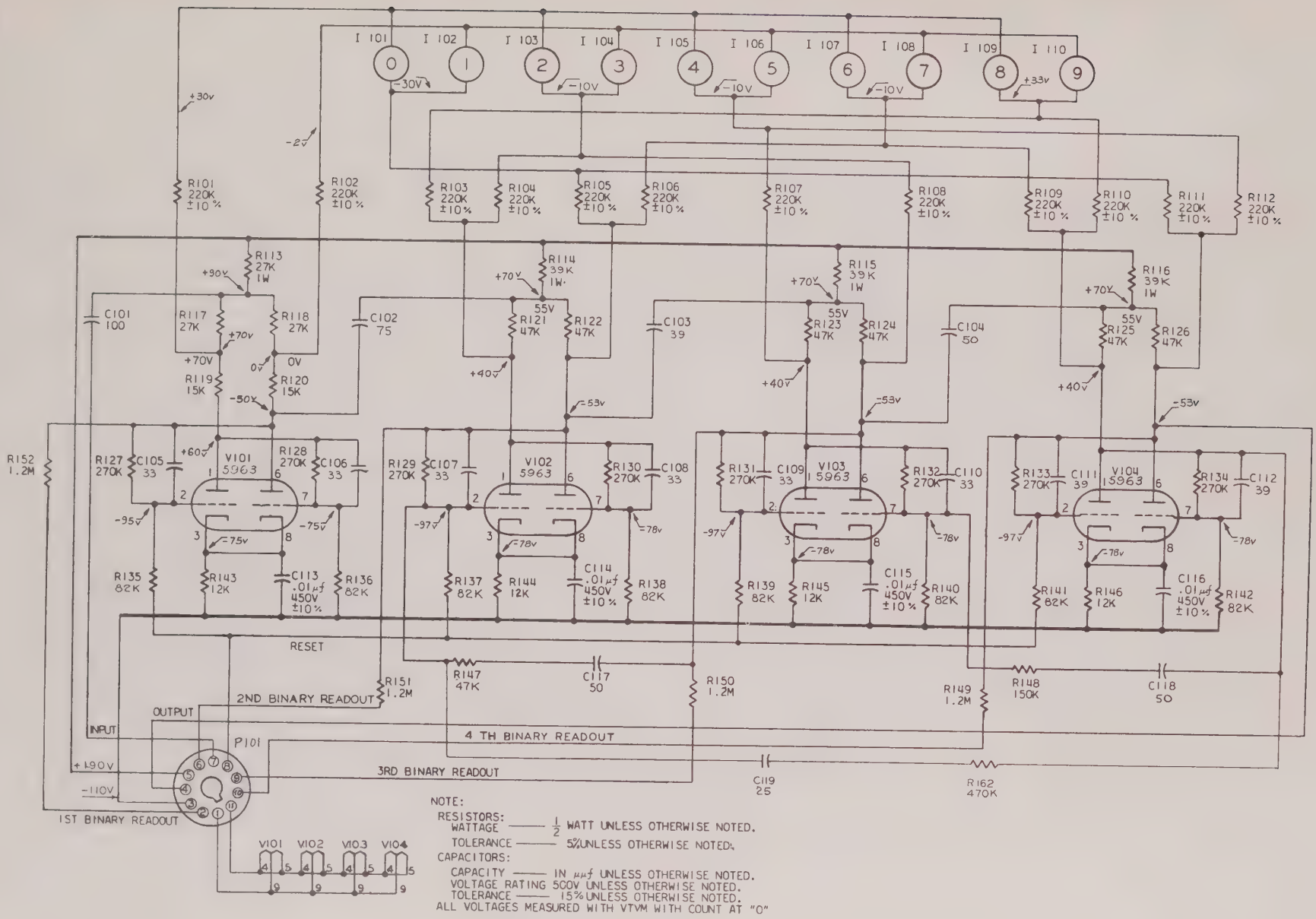


FIGURE 8. MODEL 775 SCHEMATIC DIAGRAM.

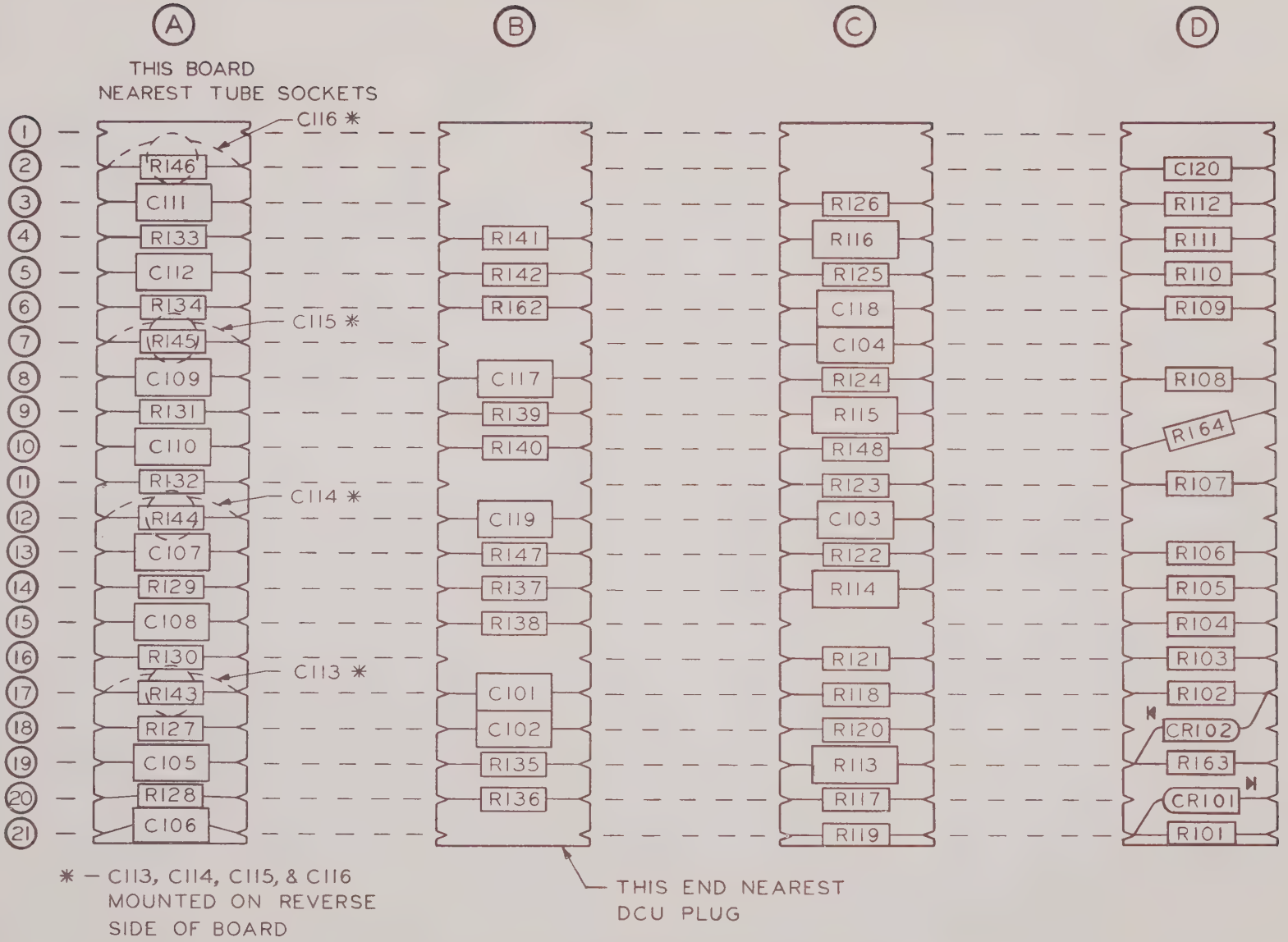
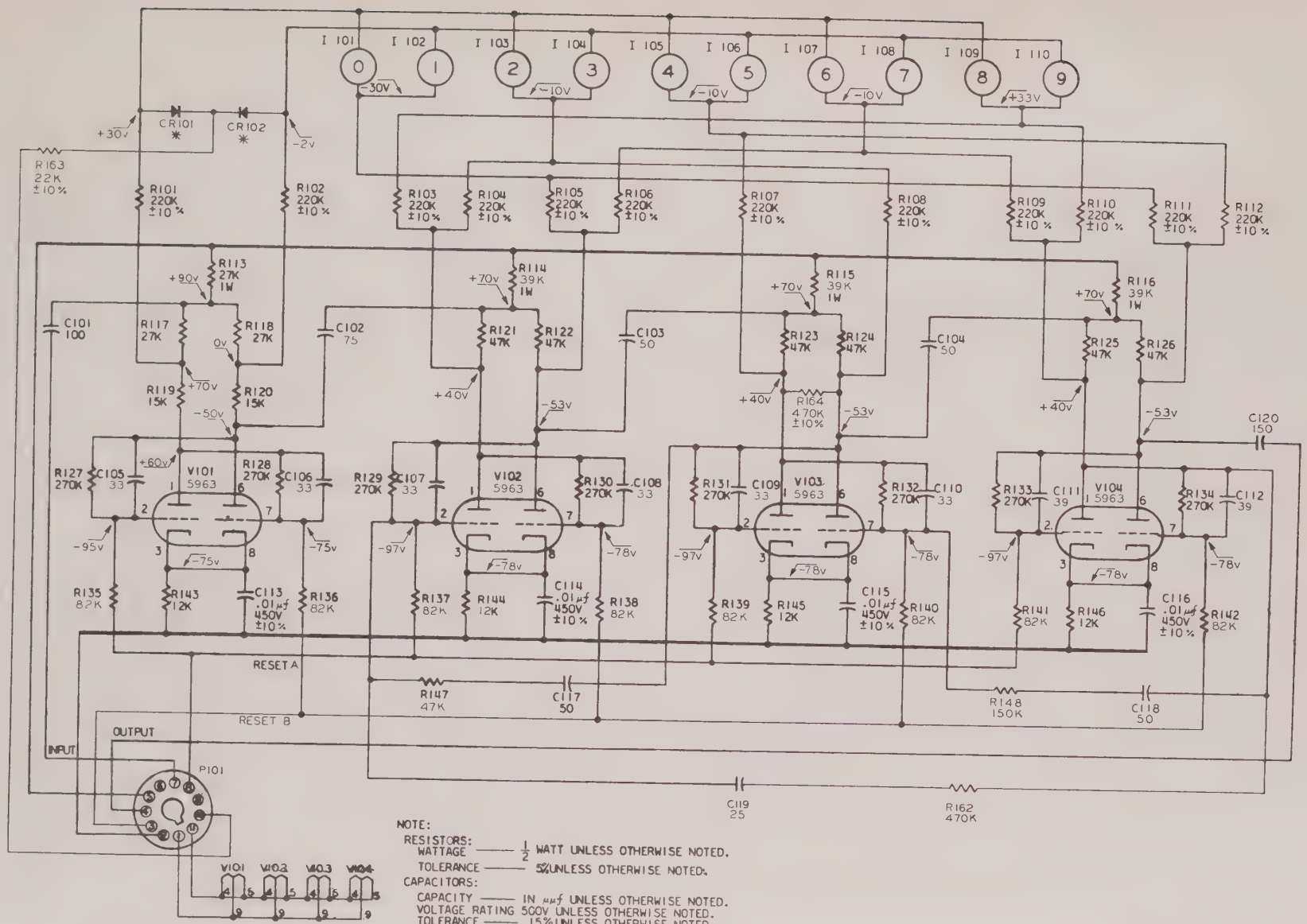


FIGURE 9. MODEL 775AJ COMPONENT BOARD LAYOUT.



NOTE:
RESISTORS:
WATTAGE —— $\frac{1}{2}$ WATT UNLESS OTHERWISE NOTED.
TOLERANCE —— 5% UNLESS OTHERWISE NOTED.
CAPACITORS:
CAPACITY —— IN µµf UNLESS OTHERWISE NOTED.
VOLTAGE RATING 500V UNLESS OTHERWISE NOTED.
TOLERANCE —— 15% UNLESS OTHERWISE NOTED.
ALL VOLTAGES MEASURED WITH VTVM WITH COUNT AT "0" AND PIN 10 DISCONNECTED.
* — DIODES ARE TO BECKMAN SPEC DWG. A775-409593.

FIGURE 10. MODEL 775AJ SCHEMATIC DIAGRAM.

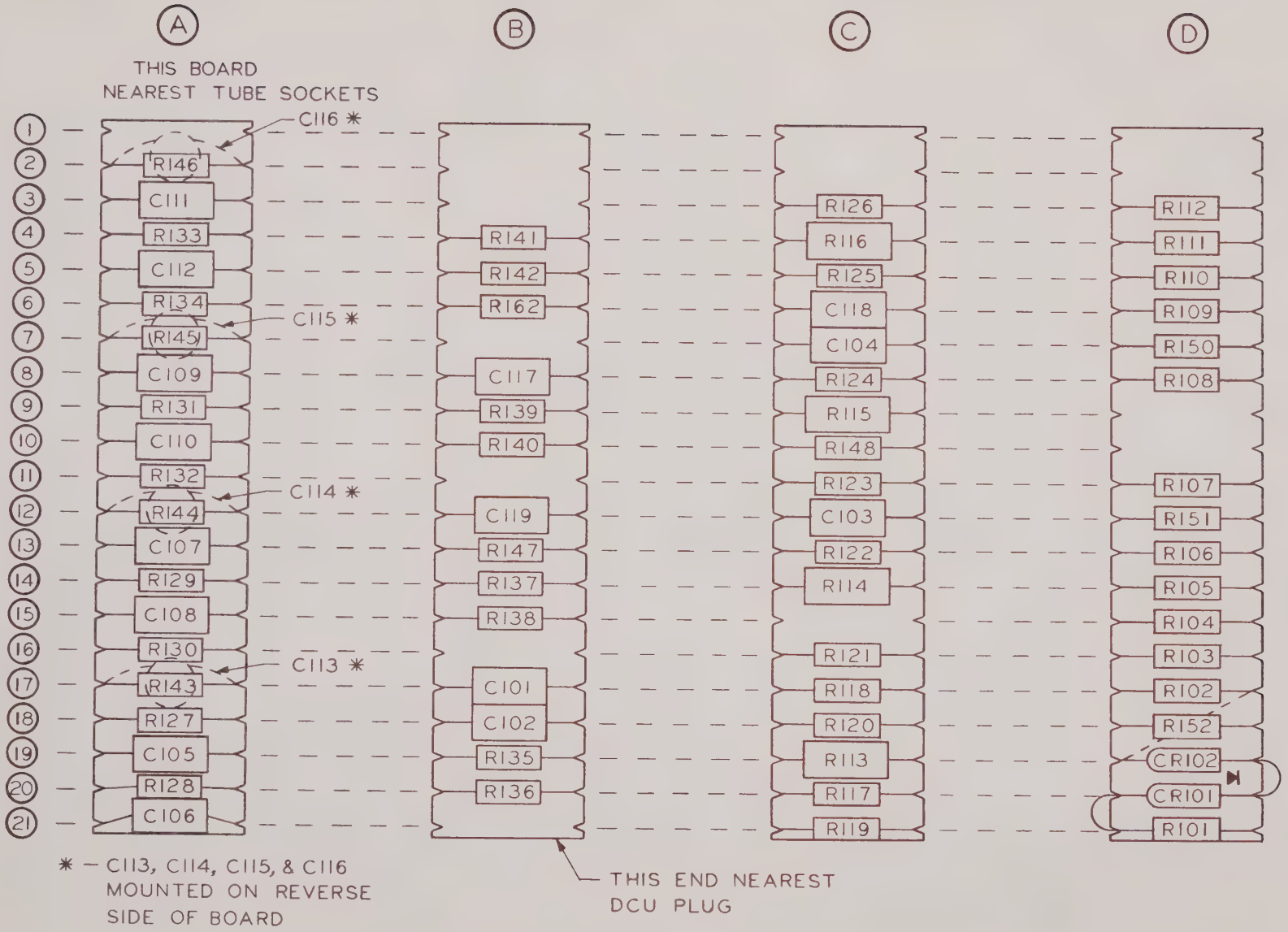
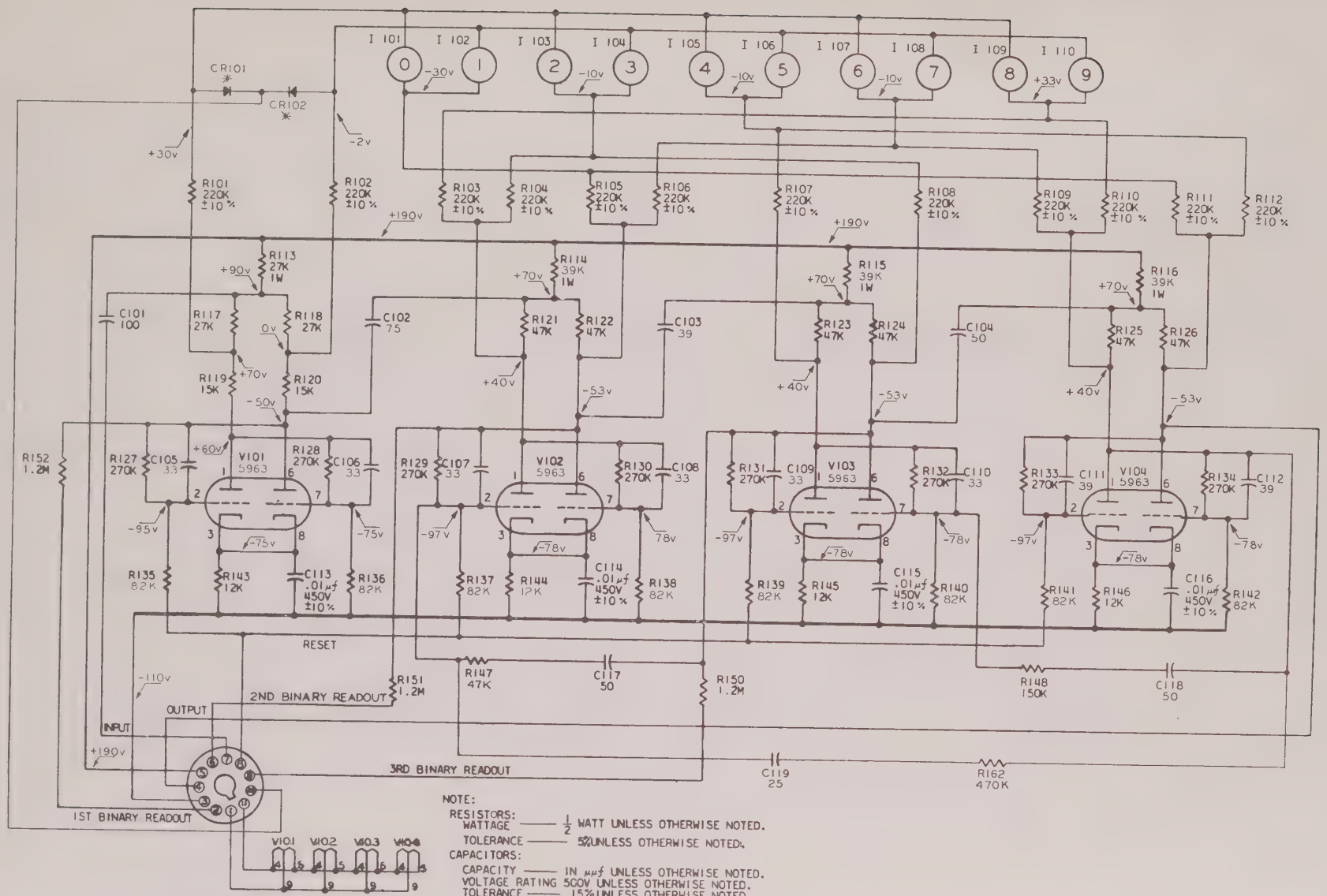
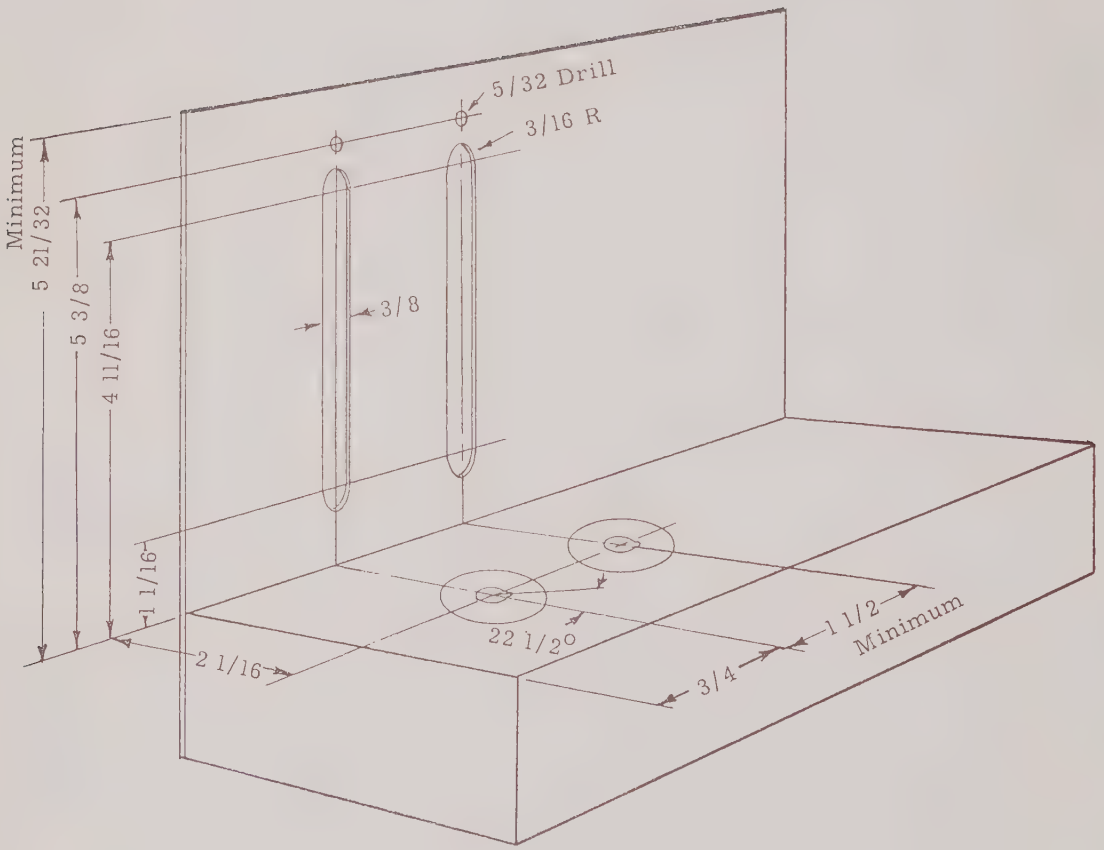


FIGURE 11. MODEL 775K COMPONENT BOARD LAYOUT.



NOTE:
RESISTORS:
WATTAGE —— ½ WATT UNLESS OTHERWISE NOTED.
TOLERANCE —— 5% UNLESS OTHERWISE NOTED.
CAPACITORS:
CAPACITY —— IN μμf UNLESS OTHERWISE NOTED.
VOLTAGE RATING 500V UNLESS OTHERWISE NOTED.
TOLERANCE —— 15% UNLESS OTHERWISE NOTED.
ALL VOLTAGES MEASURED WITH VTVM WITH COUNT AT "0" AND PIN 10 DISCONNECTED.
* — DIODES ARE TO BECKMAN SPEC. DWG. A755-404593.

FIGURE 12. MODEL 775K SCHEMATIC DIAGRAM.



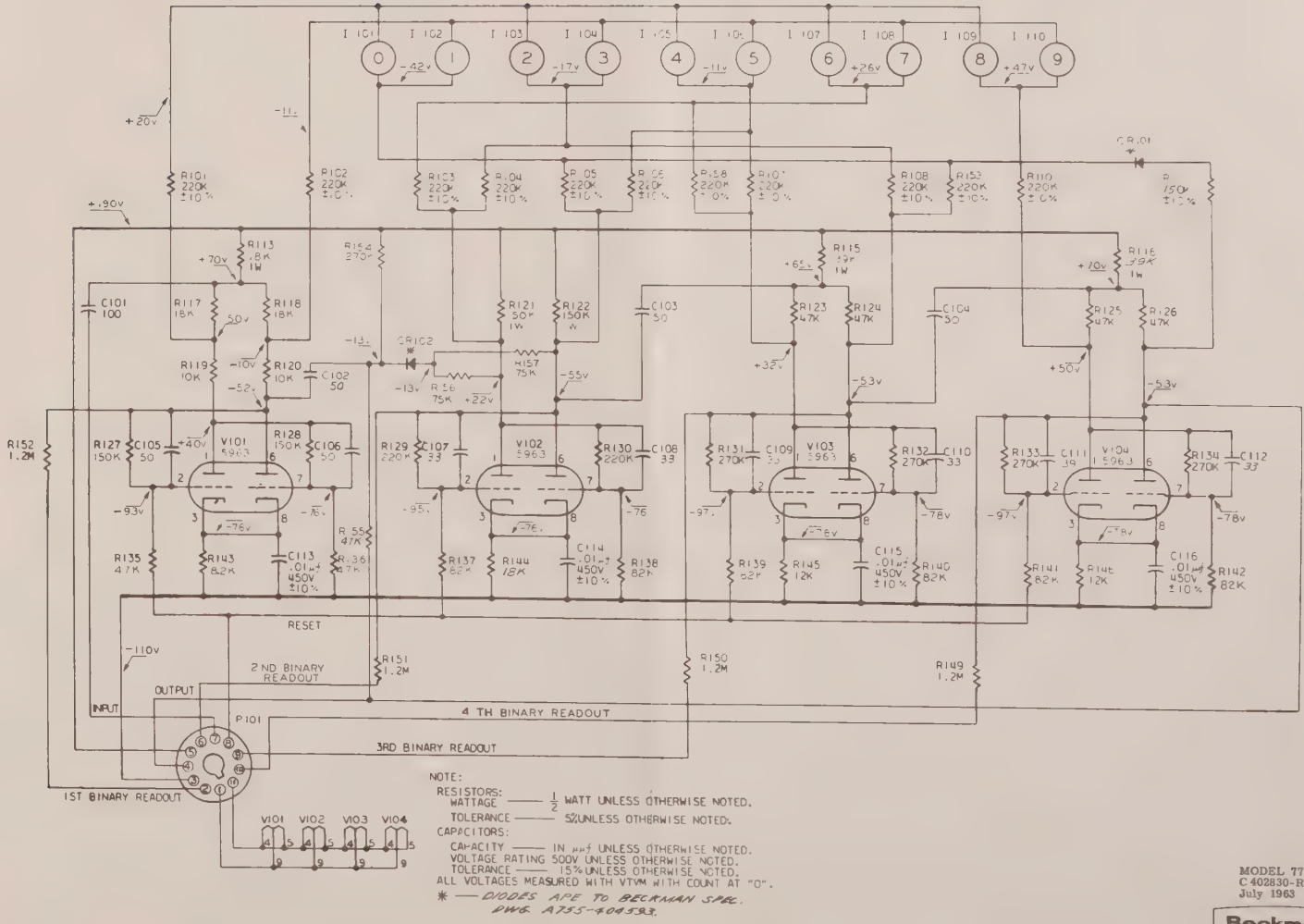
NOTE: Dimensions are based on the use of an Amphenol "MIP" 8 or 11-pin socket mounted above the chassis.

FIGURE 13. MOUNTING DIMENSIONS FOR MODEL 775, 775AJ, AND 775K.

MODEL 775R
DECIMAL COUNTING UNIT

The Model 775R DCU is basically similar to the Model 775 described in this manual but has a different arrangement of readout lines to generate a 1-2-4-8 electrical readout instead of 1-2-2-4.

The schematic diagram of the Model 775R is attached.



NOTE:
RESISTORS:
WATTAGE —— $\frac{1}{2}$ WATT UNLESS OTHERWISE NOTED.
TOLERANCE —— 5%UNLESS OTHERWISE NOTED.
CAPACITORS:
CAPACITY —— IN µµf UNLESS OTHERWISE NOTED.
VOLTAGE RATING 500V UNLESS OTHERWISE NOTED.
TOLERANCE —— 15%UNLESS OTHERWISE NOTED.
ALL VOLTAGES MEASURED WITH VTVM WITH COUNT AT "0".
* —— DIODES ARE TO BECKMAN SPEC. DWG. A755-404593.

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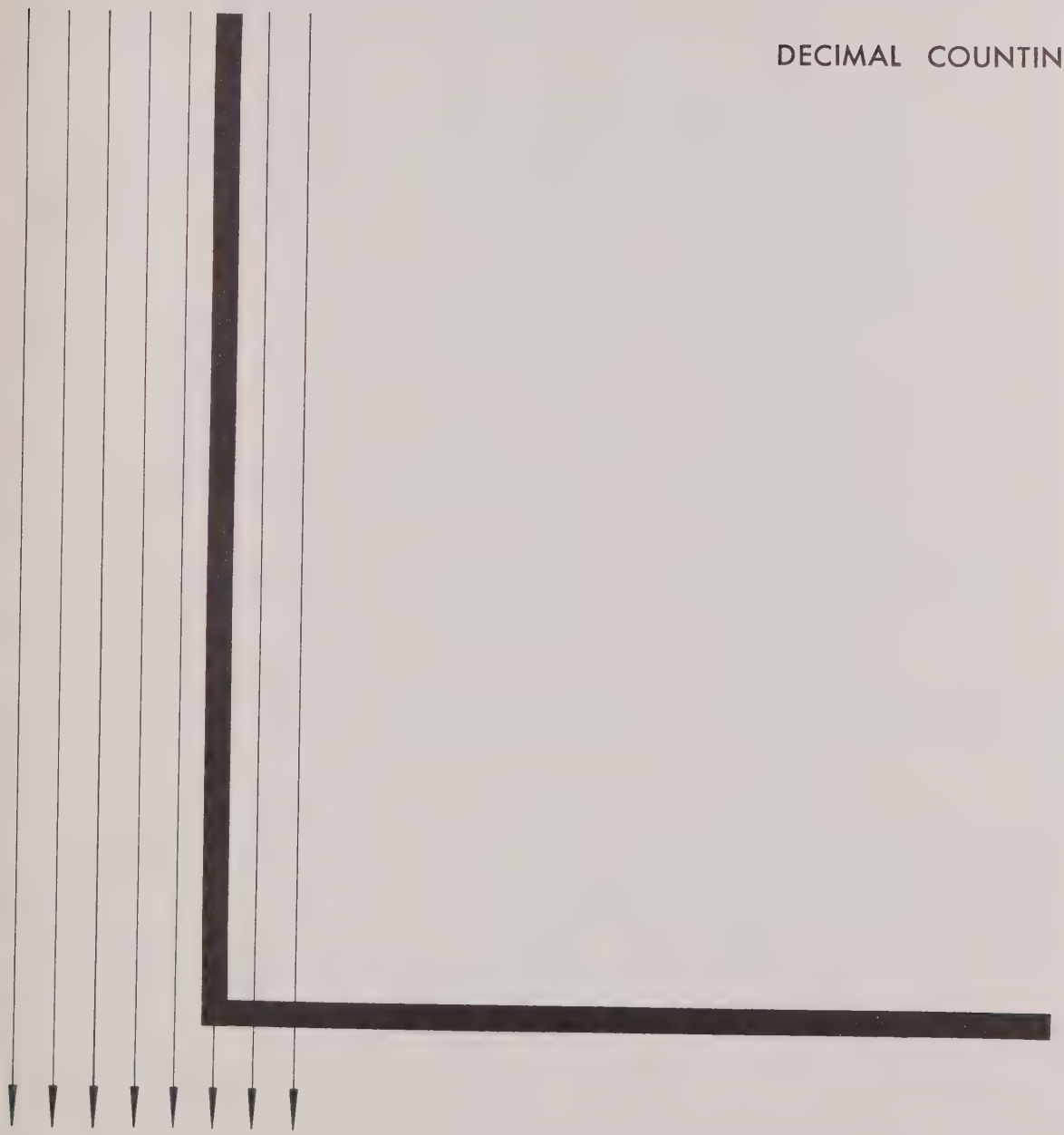
INSTRUCTION MANUAL

MODEL 774P

DECIMAL COUNTING UNIT



Beckman® INSTRUMENTS, INC.

BERKELEY DIVISION
2200 Wright Avenue
Richmond, California

1961

WARRANTY

Instruments sold by Berkeley Division, Beckman Instruments, Inc., (hereafter called "the Company") are warranted only as stated below.

Subject to the exceptions and upon the conditions specified below, the Company agrees to correct, either by repair, or, at its election, by replacement, any defect of material or workmanship which develops within one year after delivery of the instrument to the original purchaser by the Company or by an authorized representative, provided that investigation and factory inspection by the Company discloses that such defect developed under normal and proper use.

The exceptions and conditions mentioned above are the following:

(a) Some components and accessories by their nature are not intended to, and will not, function one year. If any such component or accessory manufactured by the Company and part of the item sold fails to give reasonable service for a reasonable period of time, the Company will, at its election, replace or repair such component or accessory. What constitutes reasonable service and what constitutes a reasonable period of time shall be determined solely by the Company after the Company is in posession of all the facts concerning operating conditions and other pertinent factors and after such component or accessory has been returned to the Company, transportation prepaid.

(b) All instruments claimed defective must be returned to the Company, transportation charges prepaid, and will be returned to the customer with the transportation charges collect, unless the item is found to be defective in which case the Company will pay all transportation charges.

(c) The Company makes no warranty concerning components or accessories not manufactured by it, such as tubes, fuses, batteries, etc. However, in the event of the failure of any component or accessory not manufactured by the Company, the Company will give reasonable assistance to the purchaser in obtaining from the respective manufacturer whatever adjustment is reasonable in the light of the manufacturer's own warranty.

(d) Except as stated above, the Company makes no warranty, express or implied (either in fact or by operation of law), statutory or otherwise; and, except to the extent stated above, the Company shall have no liability under any warranty, express or implied (either in fact or by operation of law), statutory or otherwise.

(e) The Company expressly disclaims any liability to its customers, dealers, and to users of its products, and to any other person or persons for consequential damages of any kind and from any cause whatsoever arising out of or in any way connected with the manufacture, sale, repair, replacement of, or arising out of or in any way connected with the use of any of its products.

(f) Representations and warranties made by any person, including representatives of the Company, which are inconsistent or in conflict with the terms of this warranty (including but not limited to the limitation of the liability of the Company as set forth above) shall not be binding upon the Company unless reduced to writing and approved by an officer of the Company.

(g) This warranty shall be governed by the laws of the State of California.

Claims for damage in shipment should be filed promptly with the transportation company.

All correspondence concerning the instrument should specify the model and serial number. This information appears on the company name plate. Any inquiry concerning details of operation, possible modifications, etc., should be addressed to the Sales Department, Berkeley division of Beckman Instruments, Inc., Richmond 4, California.

REPAIR SERVICE

Experienced service personnel and special test equipment are available at the factory to perform any necessary repairs. Every effort will be made to expedite the repair of instruments returned for servicing. Repair work will be performed only upon receipt of a written purchase order or authorization. Instruments to be repaired should be addressed to SERVICE AND REPAIR DEPARTMENT with transportation charges prepaid. Repaired instruments will be returned to the purchaser with transportation charges collect.

Berkeley reserves the right to make changes in design at any time without incurring any obligation to modify equipment previously purchased to conform to subsequent design changes.

BERKELEY DIVISION
BECKMAN INSTRUMENTS, INC.

INSTRUCTION MANUAL

MODEL 774P

With the following exceptions, this unit is identical to the Model 775 DCU described in the appended manual.

1. The readout matrix resistors (R101 through R112) and readout lamps I101 through I110 have been deleted.

2. Four diodes, CR101 through CR104, have been added. Each of these is wired from a binary readout line to the coincidence line at pin 3 of the DCU plug, P101.

3. The 1.2M resistors in the binary code readout lines (R152, R151, R150, R149) have been replaced by 470K resistors.

4. The readout lines from the first and second binaries are shunted to ground through two 2.7M resistors (R153 and R165).

5. The -110 volt bus is connected to pin 11 of the DCU plug instead of pin 3.

Component boards C and D for Model 774P are shown in Figure 1. Boards A and B are the same as in Model 775.

The schematic diagram for the Model 774P is shown on the following page. For other information on this DCU, refer to the instruction manual for the Model 775.

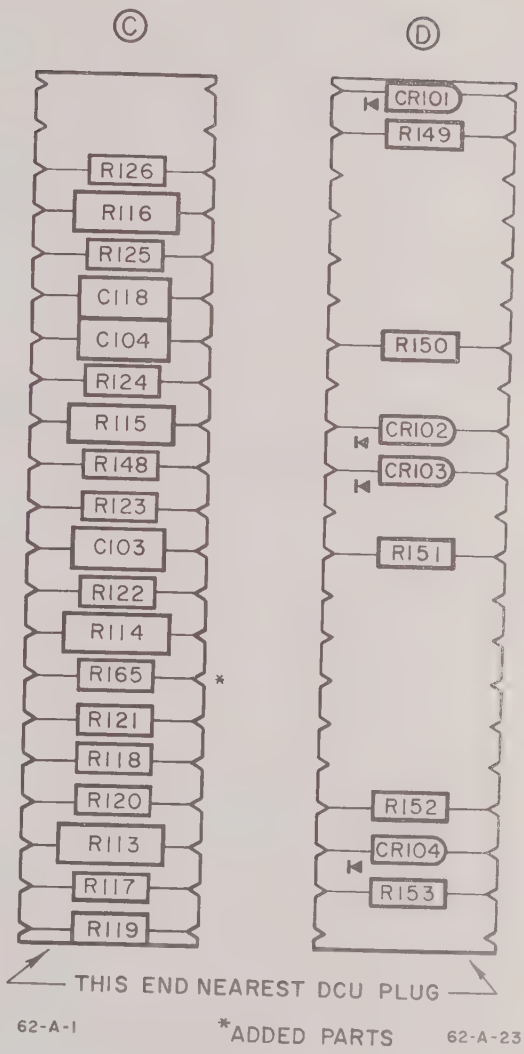


FIGURE 1. LAYOUT OF COMPONENT BOARDS C AND D.

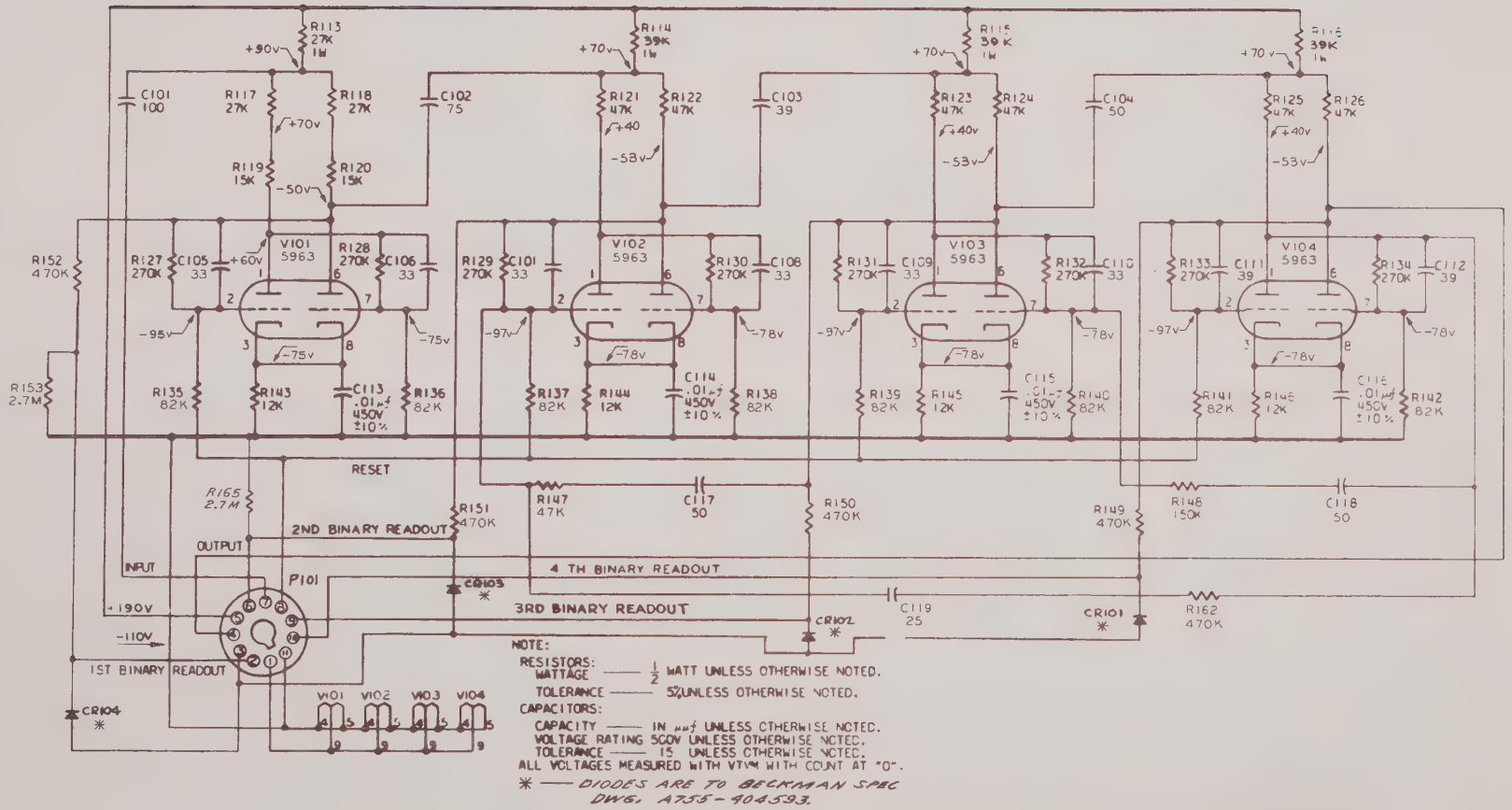


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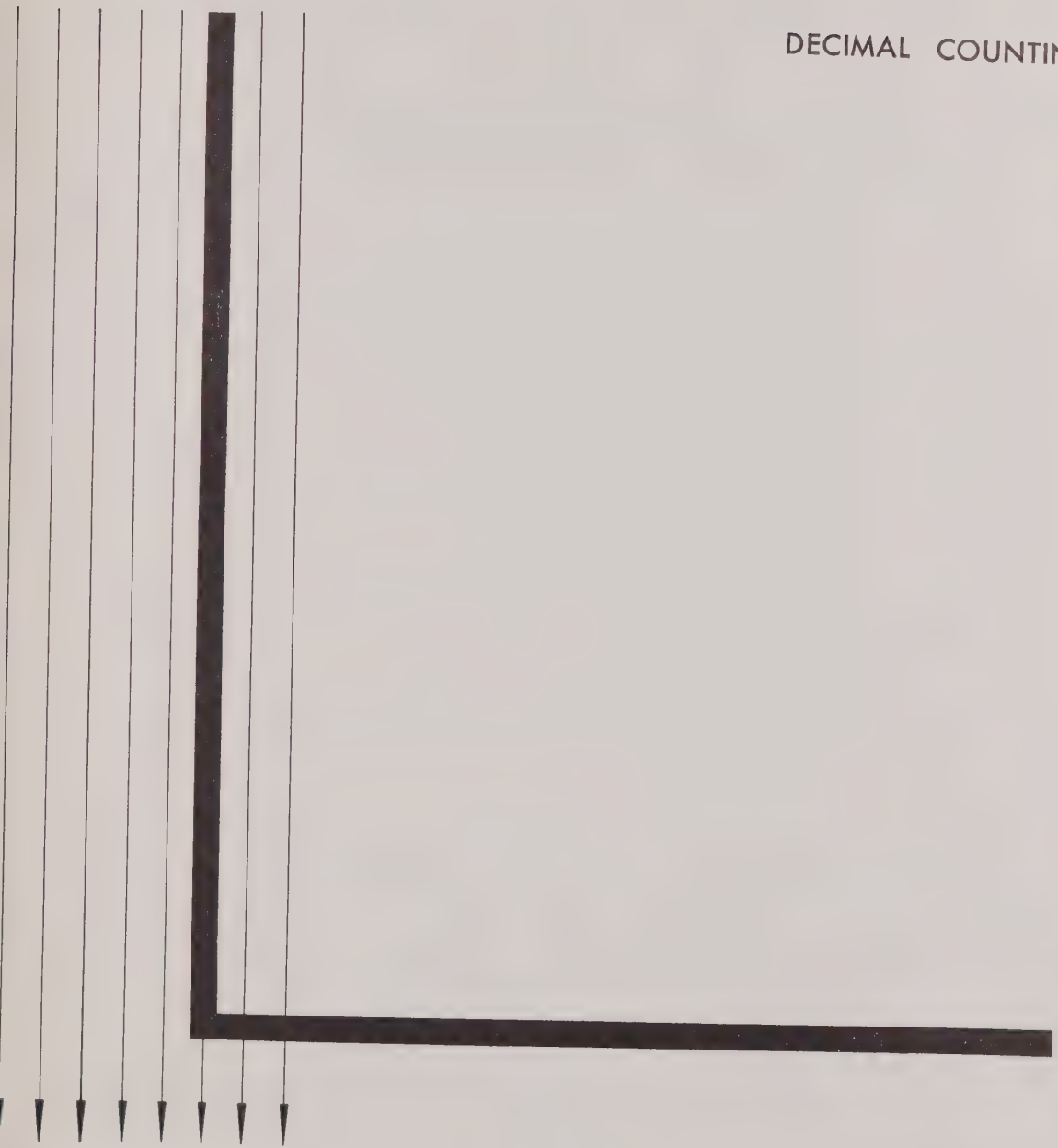
FIGURE 2. MODEL 774P SCHEMATIC DIAGRAM

INSTRUCTION MANUAL

MODEL 774P/1

DECIMAL COUNTING UNIT



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The exceptions and conditions mentioned above are the following:

(a) Some components and accessories by their nature are not intended to, and will not, function one year. If any such component or accessory manufactured by the Company and part of the item sold fails to give reasonable service for a reasonable period of time, the Company will, at its election, replace or repair such component or accessory. What constitutes reasonable service and what constitutes a reasonable period of time shall be determined solely by the Company after the Company is in posession of all the facts concerning operating conditions and other pertinent factors and after such component or accessory has been returned to the Company, transportation prepaid.

(b) All instruments claimed defective must be returned to the Company, transportation charges prepaid, and will be returned to the customer with the transportation charges collect, unless the item is found to be defective in which case the Company will pay all transportation charges.

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(e) The Company expressly disclaims any liability to its customers, dealers, and to users of its products, and to any other person or persons for consequential damages of any kind and from any cause whatsoever arising out of or in any way connected with the manufacture, sale, repair, replacement of, or arising out of or in any way connected with the use of any of its products.

(f) Representations and warranties made by any person, including representatives of the Company, which are inconsistent or in conflict with the terms of this warranty (including but not limited to the limitation of the liability of the Company as set forth above) shall not be binding upon the Company unless reduced to writing and approved by an officer of the Company.

(g) This warranty shall be governed by the laws of the State of California.

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BERKELEY DIVISION
BECKMAN INSTRUMENTS, INC.

INSTRUCTION MANUAL

MODEL 774P/1

With the following exceptions, this unit is identical to the Model 775 DCU described in the appended manual.

1. The readout matrix resistors (R101 through R112) and readout lamps I101 through I110 have been deleted.

2. Four diodes, CR101 through CR104, have been added. Each of these is wired from a binary readout line of the coincidence line at pin 3 of the DCU plug, P101.

3. The 1.2M resistors in the binary code readout lines (R152, R151, R150, R149) have been replaced by 470K resistors.

4. The readout lines from the first and second binaries are shunted to ground through 2.7M resistors (R153 and R165).

5. The -110 volt bus is connected to pin 11 of the DCU plug instead of pin 3.

6. The ground and reset line connections to R135 and R136 have been reversed so as to make the unit reset to a registered count of one instead of zero.

Component boards C and D for Model 774P/1 are shown in Figure 1. Boards A and B are the same as in Model 775.

The schematic diagram for the Model 774P/1 is shown on the following page. For other information on this DCU, refer to the instruction manual for the Model 775.

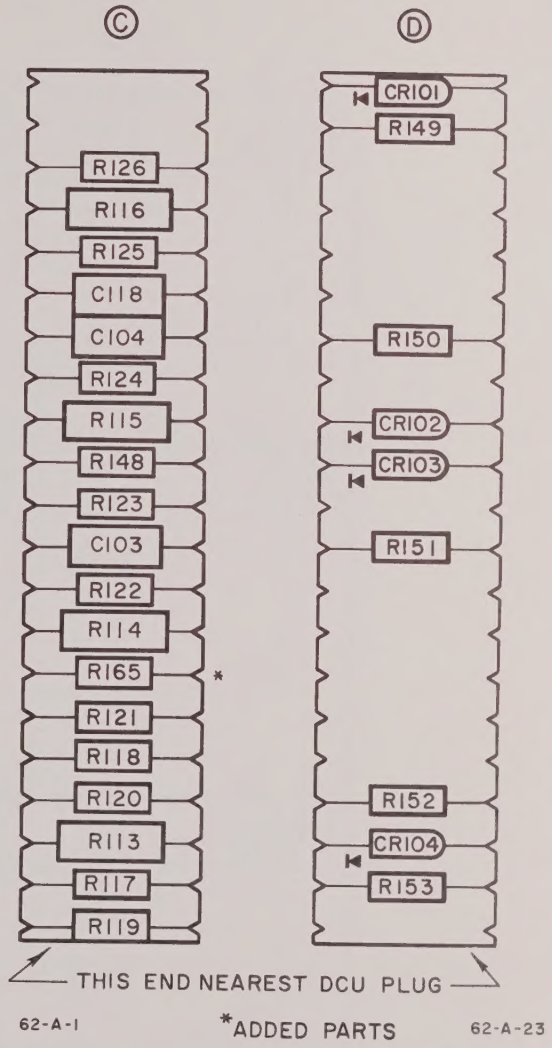

FIGURE 1. LAYOUT OF COMPONENT BOARDS C AND D.

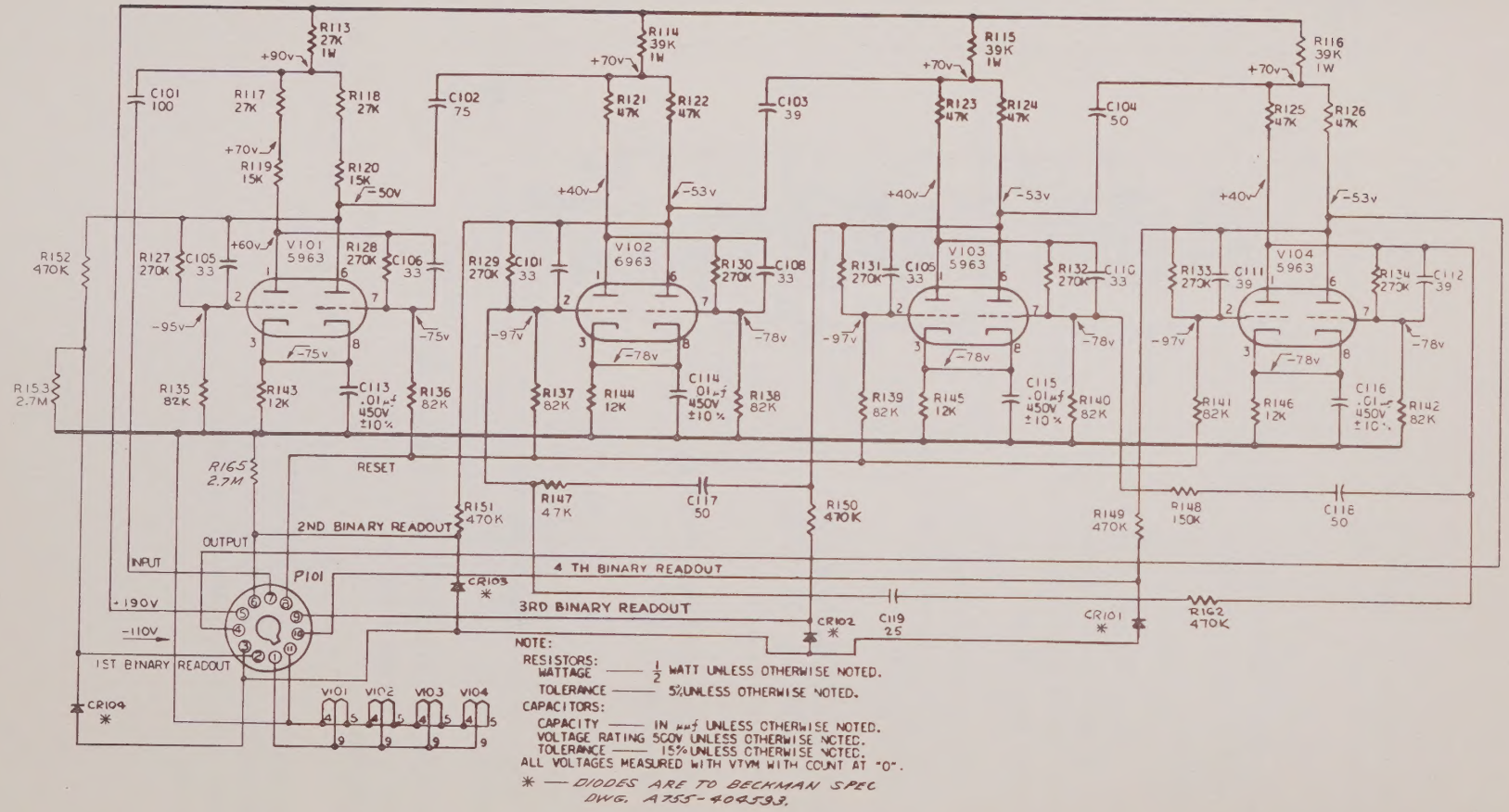

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FIGURE 2. MODEL 774P/1 SCHEMATIC DIAGRAM

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